TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. VII No. 10. OCTOBER, 1930. PRICE 6d.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2483.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

DISTRICT WORK AND THE AGRICULTURAL OFFICER.

It is often said that good wine needs no bush, but it may be doubted whether this proverb is capable of as wide application as formerly. Certain it is that it no longer holds in the sphere of industry, for no axiom is more impressed on manufacturers than the necessity for not only producing sound articles but also for selling them. Industrial leaders have awakened to the importance of salesmanship, and the fact that modern competition necessitates advertisement, and yet more advertisement.

The same problem obtains in agriculture. A Director of Agriculture is in much the same position as a manufacturer in that his goods, namely the results of the investigations of his staff, no matter how sound in themselves, are valueless until they are interpreted into agricultural practice. Just as the manufacturer must devote considerable expenditure and effort to advertising his goods, so a modern Department of Agriculture must devote a large proportion of its time, personnel and money to propaganda work and the dissemination of the fruits of research and investigation. The recognition of this problem is by no means new, but there has lately been a revival of interest in it; recent publications by the Empire Marketing Board and the Empire Cotton Growing Corporation have stressed its importance, and for this reason we welcome the article by Mr. Gilbert, entitled "Extension Work," which appears in this issue of the Journal.

What are the peculiar difficulties which impede such work in the Tropics? First and foremost it will be conceded, is the necessity of being sure that what it is proposed to recommend is a really sound proposition, and though it will be said that this is obvious, it needs to be emphasised because it is not easy always to decide. A proposal cannot, for instance, be always, or even generally judged on economic principles, because indigenous peasant agriculture does not usually work by economic standards. Recommendations should therefore be thoroughly examined from every point of view and rigorously tested. Those which satisfy the complicated requirements should be embodied in a definite policy, from which no departure should be made without full consideration. But with the framing of this policy and the acceptance of the programme other difficulties will appear. At the first glance, the problem baffles from its very immensity:

distances are great and areas wide and as an additional handicap, officers are comparatively immobile owing to the difficulties of transport. A large staff is thus essential, but as absences are frequent on account of leave or sickness, and as the majority of the rapidly increasing staff of Colonial Departments are men of relatively short experience, continuity becomes a difficult problem. The majority of the staff will always consist of natives of the country, selected and trained with as much care as is possible, but presenting in most cases, a compromise between economy and reliability. Another difficulty lies in the illiteracy of the peasant, and in some Colonies, the number of vernaculars further precludes any wide-spread use of the printed word. Problems of land tenure and local custom complicate an already difficult problem.

And so extension work in the Tropics presents problems which it will take the best energies and brains of the Department to solve, and it may be of interest to consider some of the conditions of success. The first step is to secure the peasants' confidence, for once this is obtained further progress is facilitated, and the most successful line of approach seems to be the distribution of an improved strain of some common local staple. This appeals to the peasant since it involves no modification of his customary farming practice; it requires little expenditure; and the benefits are at once apparent. The next advance will deal with the modification of some customary agricultural practice, such as transplanting in place of broadcasting or the use of purchased manures, while the most advanced stage of district work will probably be the introduction by demonstration and sale, of new implements or apparatus. The difficulty here seems to be to decide at what stage in the evolution of the implement in question is a start to be made. In introducing the use of ploughs in a region where they are quite unknown: will it be better to start with a primitive type or should the latest model of the imported article be adopted? The success of the bicycle and sewing machine supply one answer to this question, that there is another may be judged from an account of the United Free Church of Scotland Mission at Aro Chuko in the Gold Coast Colony (Guggisberg and Fraser "The Future of the Negro," page 116) about which we read "They aim at getting girls . . . to train them for their future homes. The girls live in huts *which are very similar to, but a little better than, the village huts*; then there is . . . work . . . all done in native style *but a little better* . . . they learn the importance of . . . doing things at the right time but *all in village conditions.*" Evidently the policy here is one of gradually improving conditions, by means which are easily within the native's powers.

It is partly for this reason that the policy of basing all district work on an experimental station strongly recommends itself; this enables the demonstrator to speak from definite personal experience, and helps to check any tendency to let his enthusiasm get the better of him. The same advantages apply to the subordinate staff, who can alternate the harder travelling work with the management of experimental plots and ordinary farming experience at headquarters.

In considering the actual methods used in propaganda work, it is interesting to notice the change which is taking place, and the increasing importance given today to the motor van, the cinema and the broadcaster, for such work. The particular method adopted will largely depend on the general state of education among the cultivators whom it is desired to approach. Ignorance is the basis for the suspicion with which the Agricultural Officer is so often regarded, a suspicion which is intensified by the police work which he is sometimes called on to perform; the native's inability to understand the fluctuation of market prices, for instance, which makes him disinclined to adopt a crop like cotton, can only be removed by an increased knowledge of the world and its ways, which will follow on a sound educational policy.

We may perhaps close with a word of caution. It has been suggested that Departments might make fuller use of organisations like co-operative societies or agricultural societies, and they have been criticised for not doing so (*Indian Agricultural Commission*, para. 143, p. 158). Where these societies are real working bodies they can be valuable and can afford great assistance to the Departments. Care is needed in seeing that these conditions obtain, for the responsibility for success or failure lies, in the end, with the Agricultural Department.

EMPIRE COFFEE.

THE coffee market at the present time is depressed by large supplies, much of which is of such low quality as to be of little value in commerce. Nevertheless the demand for high quality coffees persists as is shown by the fact that Jamaica's famous Blue Mountain coffee frequently realises as much as 215*s.* a cwt. Kenya coffees which ranged from 145*s.* to 54*s.* 6*d.* makes a very poor comparison. A correspondent of *The Times Trade and Engineering Supplement* (24th May, 1930), suggests that if Empire coffee planters would concentrate upon the production of the finest qualities, they would make an invaluable contribution towards the solution of the problems which now concern the coffee trade as a whole. One of the most notable events has been the formation of the Coffee Board of Great Britain which combines all sections of the industry in an effort to promote the consumption of coffee. The Governments of the various producing countries will contribute the money necessary for the campaign. London is rapidly regaining her position as a coffee centre, due in a large measure to the development of coffee production in British East Africa. Increasing supplies are coming in from India, Jamaica, British East Africa, Natal, Trinidad, British Honduras, Ceylon and Queensland. Practically the whole of their exports come to the United Kingdom.

AGRICULTURAL EDUCATION.

The Activities of the Faculty of Agriculture, Transvaal University College.

By Hubert D. Leppan,
Professor of Agricultural Economics.

South African agriculture is dominated by circumstances related to its rainfall.

Like Australia the country is divided into three hyetal regions: one having a winter rainfall, which gradually passes into one having an all-the-year-round rainfall merging in turn into one having a summer rainfall. In each of these arid and humid conditions are found and in each the unreliability of the rainfall is a common feature—the instability in this respect being greatest in the region of summer rainfall, which is the largest and the one having the greatest farming potentialities.

Needless to say the farming activities are correlated with the rainfall prevailing in each. The arid and semi-arid areas are devoted almost entirely to pastoral enterprises, arable farming assuming importance only in the better watered tracts. In the region of winter rainfall, the South West Cape, the winter cereals, wheat, barley, oats and rye are the chief products of cultivation; in the all-the-year-round part, comprising mainly the southern coastal area, because of the poor distribution of the rainfall within the year, fodder crops are the main ones cultivated; and, in the summer rainfall tract, comprising Natal, the Transvaal, Orange Free State and the Eastern Cape, those crops having a high thermal requirement are grown, *e.g.*, maize, sorghums, sugar-cane, cotton, peanuts and others.

Two faculties of agriculture have been established in the Union. The one, part of the University of Stellenbosch, serves the winter rainfall region, the other, within the Transvaal University College, University of South Africa, caters for the needs of the summer rainfall region.

The activities of the latter can be appreciated only when the main features of the farming in this area, dictated in the main by physical factors, are understood.

Going from east to west the agriculture changes from parts where cropping, because of the adequacy of the usable rainfall, is fairly assured, through a transition belt where cropping is precarious, to ranching tracts where cultivation becomes impossible because of a low and extremely uncertain rainfall. Large areas of good arable soils are absent and in general the soils are of low fertility, the chief deficiency being in respect to phosphates. The possibilities for irrigated farming are meagre.

Under these circumstances it must be obvious that the animal industry must overshadow all other branches of farming. In fact the chief purpose of cultivation here would seem to lie in catering for the needs of animal husbandry, by furnishing concentrates and fodders to supplement the pasturage.

Over the greater part of this summer rainfall region grasslands occur and towards the drier areas of the west xerophytic shrubs form the basis of pasturage. While highest on the grasslands, the carrying capacity for stock is low throughout, and is so because of the markedly seasonal character of the rainfall. During the rainy season the grass growth is abundant, but this relatively rank growth, chiefly of a tussock type, furnishes poor grazing when the dry period sets in. The grass becomes harsh, fibrous, dry and of low nutritive value. Obviously then the cattle farmed must differ in hardiness and in foraging ability to those evolved under conditions where a growth of succulent sward grasses is found, *e.g.*, in North-Western Europe. While recognising that much can be done to improve the pastures, investigational work in cattle at this College has been directed towards selecting superior strains of the indigenous Afrikander breed—a hardy breed but rather slow in maturing.

The indigenous grasses largely of a tussock type, are characteristic of regions having a similar rainfall. Not only are they markedly seasonal in growth, but their habit of growth, in contradistinction to that of the sward type, favours a high run-off which in turn promotes soil erosion, a process threatening the productivity of large areas of the country. The dominant rôle of the rainfall in this respect and in cultivation explains why moisture studies have been part of the research work at the Transvaal University College. Experiments of various kinds have been undertaken to determine effective and usable rainfall, records are being taken on specially constructed run-off plots, and lysimeters are about to be built.

Farming in South Africa is in a transitional stage between that of an extensive and intensive nature involving a change from continuous to rotative cropping. Profitable cropping systems which will maintain and improve the fertility of the soils remain to be tested and a great many rotations are being tried at the College. Although these trials have now been under investigation for nearly ten years, because of the extremely variable climatic conditions, little of a very definite nature can be said about them. It would seem though that, since the effects of green-manuring are very ephemeral in semi-arid areas, it is a practice which is unlikely to play the important rôle it does in more humid countries.

The teaching at the College must, perforce, cover a wide field. The small grains are grown under irrigation during winter and early spring in the summer rainfall region. In consequence instruction must be given in the production of cool as well as warm temperate crops, and on tropical crops for the frost-free areas of the eastern lowveld. In horticulture an equally wide range of fruits are dealt with and special provision is made for students of citriculture.

In animal husbandry the range dealt with in teaching embraces cattle, sheep, pigs, poultry, equines and Angora goats.

Naturally the curriculum is modified to meet the peculiar conditions of that part of the country which the College is supposed to serve, a brief outline of some of which has been given above.

The B.Sc. Agric. is obtained by matriculated students after four years study and post-graduate degrees are also bestowed.

Besides those in pure science and arts separate departments exist in animal husbandry, agronomy, dairying, poultry husbandry, agricultural engineering, agricultural botany, agricultural economics, agricultural chemistry, agricultural entomology, horticulture, veterinary science, and domestic science.

Since many of the conditions governing South African farming approximate closely those of other African countries, the training at the Transvaal University College should be of service in preparing technical agriculturists for other parts of the African continent. A point not to be overlooked, too, is that at this College students become acquainted with the supervision of native labour.

Situated in the healthy district of Pretoria the College is in close contact with the head-quarters staff of the Union Department of Agriculture. Members of the Faculty of Agriculture, although not civil servants, frequently co-operate in research work with the technical men of the Department of Agriculture, but their activities are not under direct State control.

DOMINICA.

The hurricane which is reported as having visited Dominica on the morning of 1st September, adds another to the list of disastrous West Indian storms. While details are at present wanting, it seems likely that further information will confirm the impression that this has been a storm of more than usual severity. The Agricultural Superintendent, Dominica, has telegraphed that there has been wholesale destruction of crops and cultivations and that terrible conditions exist at the Botanic Gardens. Fortunately the loss of life appears to have been small. The same storm swept on to Santo Domingo where the destruction to property and the loss of life have been very heavy indeed.

EXTENSION WORK.

By S. M. Gilbert,

Assistant Director of Agriculture, Trinidad.

Some Notes on Demonstration and Propaganda Work among Tropical peasantry.

"The field for demonstration and propaganda is as vast as that which remains for agricultural research." [1]

I.—Introduction.

Agriculture can be divided into two phases :—

(1) Experiment.

(2) Application.

Neither can materially aid the progress of agriculture without the other. They are complementary.

It is with methods of securing the adoption of new agricultural practices—the application—that this article deals, and in particular with those for use in the tropics *among peasant farmers.*

This type of effort has come to be called "district" or "extension" work. A little reflection will bring home to anyone with experience of tropical agriculture that comparatively little is known of what has been done in this field of knowledge either as to the best methods for developing demonstration and propaganda or as to the application of such methods among peasant farmers.

It is not convenient in an annual report for any one year to do justice to the variety of work that is being done in this direction. It is often only possible to give brief examples. There is no time for discussion. Thus it is difficult for one attempting to study the methods used to get a general view of how demonstrations are carried out in various colonies. Unless one is able to examine the annual reports for each colony for some years back one is apt to overlook important work that it has not been thought expedient to report on more than once. A symposium covering methods adopted, their application and the results obtained by the different departments, would be most useful.

Generally speaking increasing attention has been paid to this subject during the last quarter of a century, especially since the war, when the rapid expansion of staffs and their improved equipment have enabled useful progress to be made. Much, however, remains to be done.

Clear and definite declarations of policy as regards the rights of the indigenous population to its lands, as for example, by Lord Lugard and Sir Hugh Clifford in West Africa, have focussed attention on the needs of the peasant proprietors and the development of native administration in Tropical Africa generally has aided progress.

AGRICULTURAL EDUCATION.

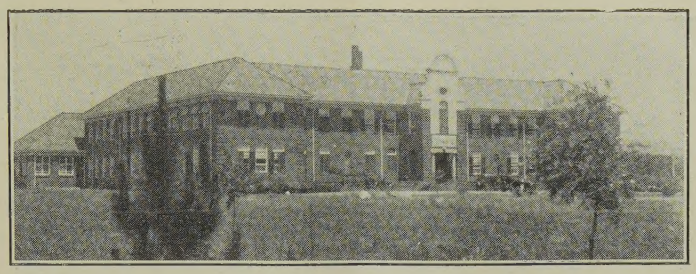


FIG. 1.—*Main Block. Faculty of Agriculture, Transvaal University College.*

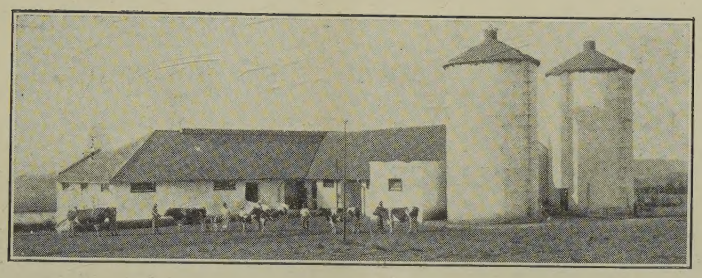


FIG. 2.—*Cow Byres. Transvaal University College.*

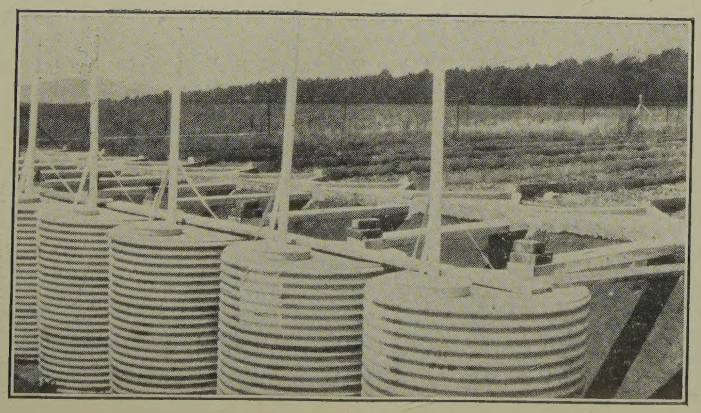


FIG. 3.—*Run-Off Plots.*

AGRICULTURAL EDUCATION.

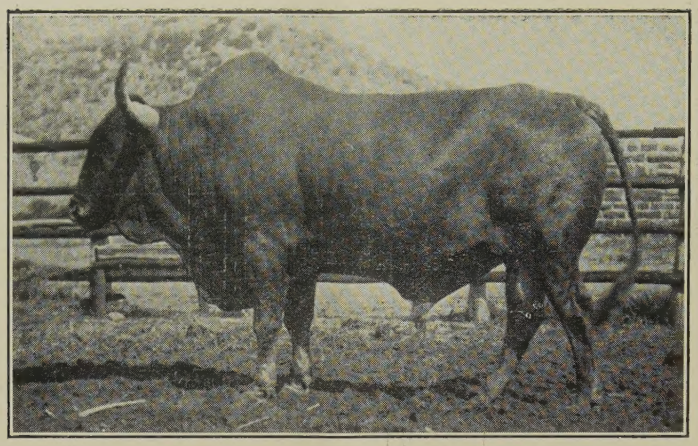
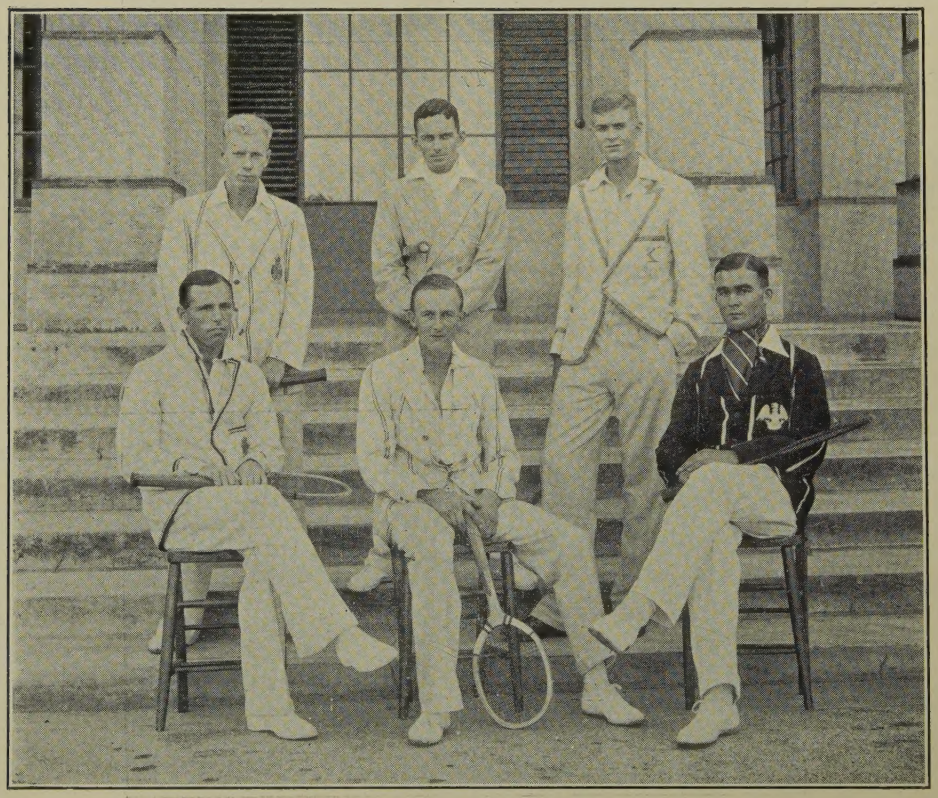


FIG. 4.—*Stud Afrikander Bull, "Buffel." Transvaal University College Experimental Farm.*

IMPERIAL COLLEGE TENNIS CLUB, 1929-30.



Standing : J. A. WIRSHING, G. G. GIANETTI, A. J. KERR.
Sitting : H. H. CROUCHER, G. M. RODDAN (*Capt.*), J. B. G. SAVORY.

Of the West Indies Lord Olivier has written recently :—

"No reform affords so good a prospect for the permanent welfare in the future of the West Indies as the settlement of the labouring population on the land as small peasant proprietors ; and in many places this is the only means by which the population can in future be supported." [2]

It is seen then that peasant agriculture is likely to be one of the most important spheres of work of the Agricultural Officer and hence the necessity for enquiry into the best methods of obtaining improvement.

II.—Staff.

Successful demonstration and propaganda must, in the end, depend on the capabilities of the available staff.

As the main object is to get improved methods adopted over as large an area, and by as many cultivators as possible, a staff is envisaged that will quickly gain friendly relations with the peasant proprietors as a whole. To do this work with Europeans is out of the question from the point of view of both numbers and cost. The connecting links therefore must be mainly trained local assistants. The lack of such assistants is frequently one of the weakest links in the chain of dissemination between department and cultivators. To quote Mr. Ormsby-Gore : "I am of opinion that what Malaya chiefly needs . . . is a really effective agricultural extension service, manned by Malays and Chinese, who have received first, a secondary education in an English school in Malaya, and then a special two year course in tropical agriculture, similar to the admirable two year course given . . . in Ceylon." [3]

This does not mean that senior and expensive officers—European or otherwise—are not necessary for supervision, advice and organisation of the work. Indeed sometimes their prestige would give success to a venture where a local assistant might fail. The system of training assistants in Nigeria is proving successful although the supply of the right type of man is strictly limited. African youths, selected by a combination of interview and competitive examination of about the Junior Cambridge Local Standard, are given a thorough training in practical and theoretical agriculture for three years. On passing out they are graded according to their ability and receive a salary on the same basis. These Africans are gradually replacing West Indian men whom it was thought expedient to engage for this work in bygone years. These young African assistants do not immediately come in contact with the cultivators. They serve a considerable apprenticeship on experimental farms, until their capacity for district work is developed. It seems probable that owing to the small supply of the right type of man in such newly developing colonies, shortage of trained African assistants may well prove the limiting factor in the development of demonstration and propaganda. Officers used for demonstration must be experienced and possess aptitude for such a vocation. A mistake in this direction may set back district work for years. Much headway is being made in the training of the necessary assistants in the various colonies, as, for example, at the Farm Schools in Ceylon, Kenya, and elsewhere.

Another point that should be considered is the length of time that an officer is left in any one district. Knowledge of the language spoken in the area is a very big step towards gaining the confidence of the farmers. With many of the African dialects, under the conditions obtaining for study at present, three to four years would not be any too long in which to acquire sufficient groundwork. On the other hand, probably an officer would become so stale after five years in one district, even with leave, as to affect seriously his efficiency. The problem is the more difficult because of changes necessitated by the very rapid expansion of Departments of Agriculture.

The above facts merely serve to accentuate the very great importance of the native assistant who is not suffering from the handicap of being unable to speak readily with the people.

III.—Methods.

Before considering the actual methods adopted it is first necessary to discuss some points that may influence the course chosen. If a bird's eye view of the position in regard to peasant agriculture is taken, four main factors at once stand out :—

(*a*) The illiteracy of the majority.
(*b*) Their state of indebtedness to money-lenders.
(*c*) The retarding effect of the system of land tenure when considered in connection with development.
(*d*) The difficulties that arise owing to local customs.

Only the passage of time and a sound educational policy can remove these difficulties. For these reasons new methods must be :

(*a*) simple,
(*b*) cheap,
(*c*) give an adequate return over old methods or save labour,
(*d*) not conflict with local laws, customs or religion.

The Demonstration Plot.—Judging by the reference to it in current literature, the above method of propaganda is now commonly accepted as being one of the most successful of those in use. For example the Director in Kenya writes :—

"These plots are proving most helpful in attracting native attention, and it is interesting to note how readily the people situated near these plots are following the work and applying the methods to their own gardens. Whenever possible special instruction is given in crop rotation and manuring. The seed harvested from these plots is distributed to any native requiring good seed." [4]

And again :—

"The Kamdars actually carry out practical demonstrations on cultivators' own fields, the ordinary agricultural operations in the interval being performed by the cultivator himself. Demonstration plots are carefully selected and as a general rule the villages are changed each year." *Bihar and Orissa.*[5]

Two ways of carrying out this method are found :

(*a*) The department hires a suitable piece of land and carries out the improvement with its own staff. It is claimed that this way tends towards accuracy in the results obtained.

(*b*) The other lies in obtaining a cultivator to carry out the improvement on his own land, at his own expense, but under the supervision and guidance of officers of the department.

In both cases it is important that control plots should be arranged for, and that accurate costs of operations should be kept. It seems, however, that the second method is better, as any occular demonstration performed by the farmer himself, must necessarily influence him more than that done by officers of a department. There would still lurk the fear, in the first case, that the department had some resource which the cultivator himself had not the advantage of. It is possible, however, that in the case of demonstrations with implements and similar work, the first method might prove best.

In the report of the Royal Commission on Agriculture in India, it says :—

"Both systems have much to recommend them and we consider that both might well be adopted in all provinces and the results compared."[6]

In Nigeria, in connection with an attempt to improve the native owned Oil Palm Groves the second method was adopted. In most cases nine adjacent acre strips were set aside and on four alternate plots the new idea was carried out by the native. The remaining strips acted as controls.

It may be as well here to mention some of the difficulties that the Agricultural Officer meets in this work.

It must first be pointed out that the locally trained African Staff has been extremely limited, so much so, that it has been the controlling factor in extending this work. Secondly, native suspicion of Government action is very strong. The question at once arises in the farmer's mind at any offer of help :—"what does this mean, and what does the Government get out of it." He is not yet used to the idea of an apparent "something for nothing." Those among the "foreign" staff—English or West Indian—with the ability to readily overcome this suspicion and quickly gain the confidence of the farmer are comparatively rare. Thirdly, conditions of land tenure often militate against progress. In areas where native holdings are strictly communally held, it is almost impossible to persuade a whole village, as a unit, to try out some new idea, which it does not profess to understand or see the reason for. In any case the final word usually lies with the village council—old men who do not want changes of any sort. Where there is a rudiment of private ownership, as in cases where tradesmen and middlemen have gained a hold on land, as for example, through the inability of a family to repay a loan, there progress is usually quicker—or in those exceptional cases where the local chief has sufficient personality to carry his people with him. Fourthly, there are not in Nigeria unofficial bodies with agricultural interests, such as the taluka associations of India which can spread a method successfully proved at suitable centres. It means that in such countries, unless funds and staff available are very large indeed, the adoption of the new idea will be slow.

The passing of the years will no doubt see the birth and organisation of more societies which have for their object the development of peasant agriculture, such as District Agricultural Societies, Agricultural Credit Societies, and other co-operative concerns.

IV.—Other Methods.

A consideration of the above sections brings one naturally to a discussion as to how best can one amplify the work of local departments, which is very likely to be hampered by lack of suitable and sufficient staff.

(*a*) *Native Administration.*

In Africa great headway is being made in developing administration through the local chiefs. In some cases a very useful foundation exists, as with the Emirates of North Nigeria, but elsewhere very careful building up of the merest traces of existing Government has to be done, as for example, in South-east Nigeria. These administrations are gradually accumulating funds and in virtue of their influence, their knowledge of the language, customs and conditions of land tenure, are able to appreciate readily the difficulties and form plans to remove them. Such native administration units can very usefully supplement the work of the department. Indeed the Director of Agriculture in Tanganyika appears to prefer this form of propaganda to that of the demonstration plots as the following extract from his annual report will show :—

"Former reports have also described the position and work of the District Agricultural Officer, who with the Native Instructors forms the Department's first line of attack. As regards native agriculture the old method of campaign, the giving of instructions to the natives with the aid of demonstration plots owned by those chiefs who could be made sufficiently interested to provide these, and with that of the very localised facilities afforded by Agricultural Stations, possessed its usefulness within its limitations. But the establishment of local native administrations possessing funds for work for their own

advancement has brought into view a far brighter prospect for progress and the officers are able now to conduct a far more effective campaign from the strong points afforded by the agricultural sub-stations maintained by the native administrations, functioning as demonstration farms and means for the increase and distribution of the best kinds of well-tested planting material." *Tanganyika.*[7]

(*b*) *Non-official Associations.*

Among the best methods of propaganda that supplement the efforts of local departments are those carried out by non-official bodies such as Agricultural Societies, Agricultural Credit Societies, and the various forms of co-operative bodies.

(1) *Agricultural Societies.*

Concentration of effort is recognised as being essential, and for this reason organised bodies are especially useful. These societies, if well conducted can be of enormous value in what may be called the "wholesale" spread of new ideas. To be successful these societies must consist primarily of agriculturalists and, further, chiefly those that depend on agriculture for their living. Secondly, the societies must be very local. Members should come from a small area with similar conditions. This will tend towards unity of effort and help to maintain regularity in attendance. Thirdly, a definite object should be arranged for each field demonstration—preferably only one object—and a special subject should be chosen for each meeting. If nothing definite is in view, interest will soon wane, attendance will fall and the society become moribund. Fourthly, these societies must have the sympathetic guidance of the local department. Successful small societies can always link up for certain purposes. In Trinidad arrangements are being made for the entire committee of each society to come periodically to Head-quarters for a day; the morning to be spent on the Department's Farms, and with its staff, the afternoon at a special meeting of the parent Agricultural Society.

(2) *Co-operative Credit Societies and Agricultural Banks.*

Co-operative societies can further progress chiefly by providing facilities to obtain the wherewithal, for example; seed, implements, credit, &c., required to effect any improvement shown to be sound.

(*a*) In some cases, as with the Agricultural Bank of Trinidad and Tobago, the conditions under which a loan is granted, entailing as they do, regular inspections by advisers of the local department, provide a lever whereby the cultivator can be strongly influenced to carry out the suggestions made to him.

(*b*) Any article on propaganda would be incomplete without special reference to the taluka development associations of Bombay. The following extract from the Report of the Royal Commission on Agriculture in India adequately describes them :—

"The taluka development associations in Bombay have been constituted under a Resolution issued by the Government of Bombay in 1922. As soon after the constitution of an association as possible, a survey of the taluka is to be carried out by the Agricultural and Co-operative Departments. Where such associations exist they have taken over the work formerly done in the taluka by agricultural associations, co-operative development committees and similar bodies. Membership of an association is open both to co-operative societies and to individuals who are willing to pay a small subscription. The associations are mainly deliberative bodies which meet two or three times a year to appoint office bearers, sanction the budget and approve the programme of work. The execution of the programme is entrusted to the secretary and a small working committee of which two members are representatives of co-operative societies in the taluka. The main object of the associations is the demonstration of improved implements, improved seed and manures. They do not, however, undertake the demonstration of any improvements unless they have already been successfully demonstrated on the cultivators' own fields by the staff of the Agricultural Department. They are not expected to undertake any large purchases and hiring out of implements or the extensive financing of the purchase and distribution of seed and manure, the intention being that they should merely advance development to such a stage that this can profitably be done by co-operative societies. If an association asks for them, the services of a fieldman are placed entirely at its disposal by the Agricultural Department, the cost being met from the funds of the association. The funds required for the work of the association are provided by a capital fund raised by annual subscriptions from co-operative societies, individuals, and villages as a whole, and by an annual grant from the Government which is equal to the income from other sources up to a limit of Rs. 1,000.

The taluka development associations work under the supervision of divisional boards, of which there are six. Each of these boards consists of two official and four non-official members, of whom two represent the co-operative movement and two represent agriculture. The board is expected to meet at least once a quarter and to submit a report of its proceedings to the Director of Agriculture and the Registrar of Co-operative Societies jointly. One of the official members is ordinarily the chairman of the board. In addition to distributing the Government grants allotted to the taluka associations on the principle described above, the board controls the distribution of the portion of the Government grant for loans to co-operative societies which was formerly in charge of the Registrar of Co-operative Societies.

The board also undertakes the distribution of the discretionary grant for propaganda purposes which was formerly administered by the Director of Agriculture. The board has also certain advisory functions. It is expected to advise local officers as to the way in which the policy laid down by the Government or by the Director and the Registrar is to be carried out in its division. It is also expected to discuss questions of general importance, and to bring to the notice of the department concerned such measures as it thinks should be taken for the economic advancement of the division." [8]

(*c*) *Seed Farms.*

The distribution of pure strains of improved varieties of seed is one of the easiest ways of putting the farmer in a receptive mood for further new ideas—the results are usually so tangible. In this sense farms for the propagation of such seeds often make good demonstration centres.

(*d*) Among other forms of propaganda that have their uses are :—

(1) Publications,
(2) Agricultural Shows,
(3) Demonstration Trains and Lorries.
(4) The Cinema.
(5) Produce inspection.
(6) The example of large Companies.
(7) Legislation.

Publications are naturally not of much value to illiterates and that is the class that forms the majority of peasant agriculturists in the tropics. Periodicals issued regularly as well as those for a special purpose by the department may provide subjects for discussion by Agricultural Societies, and give ideas to leaders for discussion among their more uneducated neighbours. Agricultural Shows are of doubtful value among the class which we are considering. The cattle section of such shows usually has more lasting value. Trains and lorries are particularly useful in demonstrating new implements and machinery.

To quote further :—

"Early in 1927, at the initiative of the Eastern Bengal State Railway, a demonstration train was arranged which made a tour of eastern Bengal lasting for about a month. The train was fitted up as a travelling exhibition by the Railway, Public Health, Agricultural, Industries, Co-operative and Veterinary departments and by the Indian Tea Cess Committee. Each department was allotted a bogey carriage which was appropriately fitted up with pictures, models and samples illustrating its activities. Open air lectures, accompanied by films and lantern slides, were given at each stop. A similar train was arranged by the Government of the Punjab in collaboration with the North-Western Railway in December last, and made an extensive tour throughout the province." [9]

"The provision of a motor van with the necessary film projection apparatus has been approved and money voted for the purpose ; it is hoped to inaugurate the scheme during 1930. It is considered that propaganda of this nature will result in improved conditions on small-holdings and in the preparation of a better product for the market ; it should also result in increased market prices for small-holdings' rubber." [10]

Under the same method might be mentioned the trip organised by the Nigeria Department of Agriculture and the Railway by which the writer was enabled to conduct a party of chiefs and agriculturalists from South-east Nigeria through other parts of Nigeria stopping for a few days at certain stations, where the attention of the party was drawn to important points of agricultural practice that appeared to be improvements on their own methods. On primitive people such trips are likely to have permanent effect.

The film is certainly a means of propaganda that will be developed more and more. Great care will have to be exercised in the preparation of such films.

Produce inspection is proving successful in several countries, especially as a means of securing the better preparation of crops for markets, for example, in Nigeria, where the grading of cotton, palm oil and kernels and cocoa, at the buying points, has achieved much.

One of the best examples of the influence for good of large companies or corporations over peasant agriculturalists is that of the British Cotton Growing Association in raising the quality and quantity of cotton exported from Africa.

Legislation too has its uses although the element of compulsion is best not used if possible. An example where this means has proved successful is that in force in several colonies forbidding the ratooning of cotton.

A sound Government Policy in regard to land can do much to prepare ground for large scale improvements in agricultural methods by quietly encouraging and assisting the change from communal to private ownership without which little permanent development can be expected, and by the adoption of ways to prevent extreme fragmentation of holdings.

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ARABIAN COFFEE.

By R. W. R. Miller, B.A. (Camb.), A.I.C., Dip. Agri. (Cantab.).

Various authorities have laid down that Arabian Coffee should not be grown at less than three to four thousand feet above sea level, but with careful attention to cultural methods the crop can be successfully grown where the shade temperature does not rise above 95°F. or below 42°F.

The term "Arabian" includes in general practice numerous varieties of which Bourbon, Mocha, Blue Mountain, Jackson's Hybrid and Kent's Selected are typical examples.

In considering the type best suited to any particular conditions it is well to bear in mind that coffee is a perennial crop, and to remember that coffee trees planted by the slaves in Jamaica are still producing a bean, which commands the highest price obtainable in the world to-day.

Coffee demands a good deep rich loam, which neither dries out quickly nor becomes waterlogged, and like most tropical crops, the distribution of the rainfall is of greater importance than the annual total. It can safely be said that in districts where the rainfall is less than two inches in any one calendar month coffee cultivation is liable to prove a hazardous business, unless irrigation water is available.

The system of farming which the experienced planter aims at is one which will bring him in a regular crop each year, rather than a bumper crop every third or fourth year and a crop moreover which by its extreme demands on the plant's virility leaves the estate open to the attacks of the several diseases to which coffee is unfortunately liable.

Let us assume that the intending planter becomes possessed of virgin forest soil. He has first to decide on the acreage he intends to put under coffee. Under average planting conditions he would have approximately 600 trees per acre or 60,000 to one hundred acres and as it is essential that regular inspections of *all* the trees should be made it can be laid down as an axiom that every hundred acres of coffee demand the undivided attention of one overseer.

Let us not forget that a coffee estate producing one hundredweight per acre costs the same to cultivate and bring into bearing as land producing five or six times as much.

Before preparing land for the nursery, which should be near permanent water (to save labour in the daily watering), the planting programme must be settled. Given a six weeks planting out season it is safe to assume that one man cannot supervise thoroughly more than a twenty-five acre planting, though where additional skilled supervision is available this can be increased in proportion.

There are roughly about 500 coffee seeds to the pound and for every acre an allowance of three pounds of seed (with a 66 per cent. germination) should be made. As for the last six months before planting each seedling will occupy thirty-six square inches of ground, the following data may prove useful:—

To plant	1 acre	a nursery 100 ft. x 40 ft. is required.
Do.	10 acres do.	100 ft. x 400 ft. do.
Do.	25 do. do.	250 ft. x 400 ft. do.
Do.	50 do. do.	500 ft. x 400 ft. do.

Beds should be prepared the length of the nursery and four feet wide with an interval of three feet between the beds. By this means it will be possible to inspect and handle all seedlings with the least inconvenience. All coffee land, for a nursery or for field planting should be cleared and thoroughly uprooted. Even leguminous trees, which appear likely to prove useful as shade, should be removed, as large trees alter the alignment of the coffee bushes and diminish the number of plants per acre.

The land should be thoroughly cultivated and cleaned, and particular attention should be paid to the removal of all creeping grasses and rotting roots, in such time that nine to ten months are left between the date of planting the seed in the nursery and the actual transfer of the seedlings to the field.

(The question of planting at stake is not recommended with this crop, as it is essential from every point of view that a block of coffee should present an even stake.)

The choice of seed is wide and if possible the planter should himself visit a neighbouring farm and himself select the bushes from which his seed may be taken. In this respect it is well to remember that the coffee crop, though for the first few years it is produced on the primary branches, will eventually be borne on the secondaries and tertiaries and the selection of seed trees should only be made amongst those which have sturdy primary branches, of at least three quarters of an inch in thickness, as good secondaries can never be produced from whippy parents.

In this respect, experience has shown that those parent trees, whose first leaves are of a copper colour on unfolding, prove slow steady growers with a strong constitution, and it cannot be too strongly emphasised that the successful coffee planter's motto should be "slow and steady." Moreover this type throws as a general rule remarkably few "rogues" compared with most other varieties.

The seed should be planted, in parchment, hilum downwards one inch deep, one inch apart in the row and with four inches between the rows. The soil should be pressed down firmly and a daily watering made late every afternoon through a fine nozzle.

Shade, consisting of grass or palm leaves, should be erected from three feet to four feet above the ground (not lower, as otherwise inspection is made more difficult). After six weeks to two months germination should take place and after the cotyledons have deepened

in colour the seedlings should be removed and, after having their roots washed and carefully inspected, should be planted out in other shaded beds, six to nine inches apart, depending on the length of time it is contemplated keeping them in the nursery.

The life of a coffee bush depends on the health and efficient working of its tap-root and therefore at each stage of transplanting the roots should be washed and each root stock closely inspected.

At the same time as the nursery is put in hand the area intended for the first year's planting out should be cleared, stumped, uprooted, all the cleared material burnt and spread evenly over the soil. At this juncture it is necessary for the planter to decide whether, or to what extent, he intends to shade his crop. The various authorities differ considerably on this point and the writer's opinion is that this is a question that each planter must decide for himself.

It is recommended that windbreaks of *Grevillea robusta* should be planted every hundred yards throughout the plantation, at right angles to the prevailing wind, and that shade trees should be planted at 30 feet intervals throughout the coffee area. For shade, varieties of *Albizzia* (not the *mucronata* variety which is liable to lose its branches which fall and break the coffee) are recommended, but in all probability the planter will be able to choose a local tree, belonging to the *Leguminosae*, which may prove a suitable shade. It should always be borne in mind that shade should be only sufficient to prevent overbearing.

Starting off in this way, as his coffee grows the planter can decide whether the shade is too extensive and so diminish it until it is requisite to the conditions which pertain in his plantation.

Shade undoubtedly limits the crop, but it preserves the moisture in the soil and so renders the plant less liable to suffer from pests and disease. On the other hand pests, such as the coffee bug (Antestia), delight in heavy shade. On the whole it can be said that a moderate shade will usually be found beneficial.

The land required for planting out should receive a thorough cultivation till a fine tilth is secured and then staked out for planting.

Planting is usually done either eight feet by eight feet, nine feet by nine feet, or ten feet by eight feet and the respective number of trees per acre 680, 538, 544 per acre. The latter is recommended as one in which inter-cultivation can be done either by a small mechanical cultivator or by a small plough drawn by a single mule or ox. Holes should be prepared two and a half feet square and two feet deep and the earth removed from the hole should be exposed to the sun's action till immediately before the planting season.

When the transplanted seedlings in the nursery have 10 to 12 leaves and when the area to be planted has received a good soaking and there is the prospect of a further six weeks rainy season, planting can commence. This is undoubtedly the most important operation in the life of a coffee estate, for any faults in the root system will in all probability not be detected until the first heavy crop has been taken off four or five years hence, at which time any supplied plants will be severely handicapped by the height of the surrounding coffee and can only become willowy bushes incapable of pulling their weight with the rest of the estate.

Planting.

As coffee is a surface feeder the customary practice is to nip off the taproot before planting out in the field so that the lateral surface roots may develop to as great an extent as possible. It cannot be emphasised too strongly that the future prosperity of a plantation depends to a very considerable extent on the care which is exercised in the early stages of the plant's growth.

One Overseer should be stationed in the nursery to watch over every plant as it is lifted and another should supervise the actual planting out in the field. As a rule it is found that one man can only watch over the efforts of, at the most, six planters-out, as otherwise the number of plants which do not "take" will be high.

After planting the earth should be turned back leaving a collar of earth around the roots which on settling should not sink below ground level.

After Cultivation.

Once the young coffee trees are established in the plantation it is well to inter-plant with some suitable green manure to enrich the humus and at the same time to keep the soil cool by not exposing it to the direct rays of the sun. Different coffee countries have their different cover crops but in the writer's experience a liberal sowing of string beans is hard to beat. These by covering the ground quickly lower weeding costs and improve the soil texture considerably. Moreover where the crop is being established on a narrow financial margin the seeds can be sold off the farm for a substantial sum. Where, however, an immediate financial return is not of the first importance, the cover crop should be turned in as the first pods are beginning to ripen, as by this means the soil obtains the maximum benefit.

Mulching and Manuring.

The value of a heavy grass mulching is too often not realised by coffee planters. In the Blue Mountain district of Jamaica, planters grow two acres of Guinea grass for mulching each acre of coffee and in the writer's experience a heavy grass mulch, some nine inches in depth, does more to keep the plants in good health and ward off disease than any other treatment.

Coffee, like other members of both the lower and higher orders of life, suffers most when carrying its crop and the timely application of

a nitrogenous fertilizer keeps the plant in good heart and tends to avoid the "gone back" appearance which so many coffee plantations exhibit after the crop season.

A light dressing of phosphates usually proves beneficial, but the coffee crop as a rule does not respond to treatment with potash.

Where manure is applied it is well to bear in mind that the feeding roots of the coffee plant are mainly concentrated in a circumference immediately below the outermost leaves of the bush and the manure should be forked into the soil at these points.

Irrigation.

Where coffee is grown in regions which receive at least two inches of rain during every month of the year irrigation is as a rule unnecessary, but where, as occasionally happens, resort must be made to this method of keeping the plant alive, every effort should be made to avoid the washing out of the soluble plant food from the soil. Too often irrigation only means the leaching of the soil and the exposure of the surface roots to the hot tropical sun. Such "soil-washing" can achieve no lasting benefit and moreover each irrigation brings the plant roots nearer the surface and renders increased irrigation essential.

Irrigation, as with other artificial stimulants, has its disadvantages, one of the chief of which is the extreme liability of the coffee plant to produce a "flush" of flowers some two to three weeks after each irrigation. This flushing where irrigation is a regular part of the cultivation programme, results in the necessary picking all the year round of fly crops, apart from the main crop, and the plantation never really enters on a true resting stage.

After Cultivation of the Soil.

When coffee is three to four years old it is safe to assert that with a correct spacing the roots of the bushes will be contiguous all over the estate. It will therefore be apparent that cultivation with a heavy or light hoe can only be attended by the destruction of a considerable number of the coffee rootlets and a corresponding diminution of the plant's ability to absorb its food supply. All that the soil needs is a thorough aeration and this can be best accomplished by means of the forked hoe which should be used to prize open the soil without interfering with the root system. In this way alone can the soil be thoroughly aerated and planters too often forget that roots as well as leaves must breathe.

Where weeding is a part of the plantation system the weeds should be cut off close to the ground before they seed and not uprooted, as clean and thorough cultivation exposes the soil too much to the devastating rays of the tropical sun.

Pruning.

Pruning is next to planting and picking, perhaps the most important of the coffee planters' field operations. Unskilful pruning can do more to ruin a coffee plantation than would be deemed possible and therefore only skilled and well trained workers should be employed in this task.

There are several systems of pruning observed amongst coffee growers and these in the main depend upon the available labour supply.

The chief systems are known as :—

(1) Ordinary pruning.
(2) The Agobiada system.
(3) The Costa Rica system.

In the first and third systems the plant is cut back at three stages of its growth, *i.e.*, knee-high, loin-high and breast-high—these three checks tend to stimulate a study growth of primary branches fitted to carry subsidiary branches capable of bearing several subsequent crops.

A striking example of the value of this cutting back was observed by the writer amongst the coffee plantations of Kilimanjaro in 1926. A planter, who in 1923 had planted over five acres on the nine feet by nine feet spacing, found himself with a superfluity of plants in his nursery. He used these by interplanting with the idea of removing the interplants after taking one crop off them. While the original plants had been put into well prepared holes, the surplus plants in his nursery were put in anyhow. To avoid overcrowding his original plants he cut back the interplants. When the writer visited the estate the first crop had been taken off. While the untrimmed plants exhibited all the usual signs of exhaustion, yellow leaves attacked by rust and whippy branches, the cut back transplants showed a vigorous growth of good healthy wood bearing an abundance of glossy, dark green leaves. The contrast was so vivid that the field presented the appearance of a chequer board of green and gold.

In the first system the usual practice is to remove every alternate secondary growth on each side of the stem as shown in the diagram. (Fig. 1, *see* page 268.)

This avoids overcrowding of the branches and permits the free interplay of air through the coffee tree. The unwanted shoots should be removed as the bark begins to show brown with a sharp pair of seccateurs and any tearing of the tissues should be very carefully avoided.

The Agobiada system starts shortly after planting and consists of bending back the main stem and pinning it to the ground by a cut twig of hard wood. (Fig. 2.)

Three or four branches are then allowed to grow and these are cropped till exhausted, and as one branch has finished its economic usefulness another is allowed to succeed it.

The Costa Rica system is mainly resorted to where an extensive labour supply is not available, for it must not be forgotten that pruning induces extra growth and necessarily results in an increased need for pruning. In this method the bushes are cut back when knee-high and then two main stems are allowed to grow (in the first system only one stem is favoured) at breast high the process is repeated and so four stems are left. In theory the branches are supposed to hang over with the weight of the crop, but this is unfortunately not always the case. (Fig. 3.)

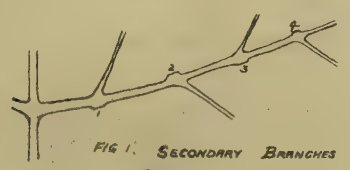

FIG 1. SECONDARY BRANCHES PRUNED AT 1, 2, 3, 4.

FIG. 2. ACOBIADA SYSTEM. FIG. 3. COSTA RICA SYSTEM.

Diagrams showing methods of Pruning

The branches below the "cut" are allowed to crop once or twice and are then removed, until eventually there are no bearing branches below the point at which the stem was first capped.

In the writer's opinion the last two methods of cultivation limit the economic life of the tree and the slow but sure method of growing the plant in accordance with the demands of the climate and the soil rather than pandering to the exigencies of the labour supply is the only one which can ensure permanent success.

In short, where a sufficiency of labour is not available it is better to avoid undertaking the, at all times, hazardous adventure of coffee planting.

Picking.

The picking of coffee should be organised before the crop is ripe. Like cotton the crop is harvested over a period and in a well regulated estate five pickings at most should be sufficient to garner the whole crop.

Coffee picking is always conducted by "task" and no coffee which is not perfectly ripe should be paid for. Coffee is always bought on quality and the admixture of unripe cherries can only lead to an undesirable diminution in the price per ton.

Care should be exercised that the coffee bushes are not damaged, as although damage in picking is not so serious as in the case of cocoa, serious losses may be caused by unsupervised picking.

Preparation.

The coffee seed as in the case of several tropical crops such as sisal and flax requires fermenting before marketing. After picking the coffee is "pulped," that is to say the fleshy fruit is removed from the seed by mechanical means. Usually the fruit is run down a water channel and passed through either a disc or breast pulper. Both types have their advocates but it can be safely stated that for a large estate, a combination of both types such as that made by Benthall is most satisfactory.

After pulping the coffee is fermented. The coffee cherry consists of fruit and seed. The seed is surrounded by a thin layer of vegetative skin, known in the trade as "parchment." This parchment is attached to the fleshy part of the fruit by a gelatinous "glue." This glue is chemically a pectin. Pectins on fermentation are turned from sticky, insoluble resin-like substances into soluble pectoses. The pulped coffee is placed in heaps, as in the case of cocoa, and allowed to ferment over 24 to 60 hours, depending on the temperature. When fermentation is complete, the seed is harsh to the feel and has lost all its slimy touch. Over fermentation should be sedulously avoided as it is bound to result in a discoloured bean with bad liquoring qualities.

After Preparation.

The coffee should now be washed and thoroughly dried on close-meshed wire trays. Mechanical drying is necessary where large crops are harvested but with mediun crops sun drying is usually resorted to. The crop is considered dry and marketable when a bitten seed shows no indentation. The crop is shipped for the most part in parchment in bags which weigh twenty to the ton as it has been found in general practice that coffee cured and cleaned (of its parchment) in London fetches a better price than that treated locally.

Pests and Disease.

The present article is not the place to describe either briefly or in detail the troubles which coffee is heir to but it can be briefly stated that sound agricultural practice limits the ravages of disease and pests and that, perhaps as with no other crop, coffee responds better to judicious cultural conditions.

RATIONALISATION.

By H. M. Leake.

Concluded.

IV

Control over the processes of production is seen to be one of the primary requirements for stability in tropical agriculture and it must be an intelligent control, capable of interpreting and applying all the latest teachings of research. The question arises, how is that control to be exercised; and it has to be exercised under the very different conditions under which tropical agriculture has been shown to be conducted. The essence of this control is an area sufficiently large to render effective the methods which are adopted. Particularly it must be of a form capable of instituting preventive or curative activity against transmissible disease and must, therefore, include supervision over cultivation with the object of developing a healthy crop. It must also provide for supervision over preparatory processes of the product to ensure the necessary standards of purity and uniformity. Rarely does the present unit of tropical production form a sufficient area to give the requisite influence and the practical problem is one of combination.

The methods of effecting combination are various and the appropriateness of any one of these methods naturally depends in part on the character of the combining units and, in part, on the object to be attained. The first method which may be considered is co-operation. Co-operation has many successes to its credit but, outside the financial field, they are mainly concerned with the question of marketing. Co-operative activity, for such it is in all essentials, has assumed in recent times another form in the research organisations. These are combinations for financing the investigational work into the fundamental problems underlying practice. But here there is no control over practice and the adoption of the results of that work are left to the option of the component units. Nowhere, as far as I am aware, not even in Java where an intricate co-operative system in advance of any other tropical country has been developed (*Tropical Agriculture*, Vol. VII, No. 3, p. 59), has co-operation been used as a means of controlling the methods of production. Nor is it easy to see how a solution can be found in co-operation. Control presupposes a restriction of individualism and presupposes an authority capable of imposing its will against the judgment of some, if not the majority, of the component units. Co-operative organisations can, and do, employ a technical staff capable of interpreting the latest results of research, they can, and do, employ trained staffs for the preparation of their produce for the market where the process requires special skill, but the two cases are very different from that under consideration. The latter partakes of the essentials of a factory; the supervisor possesses authority over the employees and can be judged by the quality and quantity of the output in relation to the intake. In the former there can be no such authority over the actual operatives in the field and output is not so clearly related to effort that responsibility can be shouldered on that test alone. The technical staff can only hold an advisory position in these circumstances and the decision as to the adoption of that advice or the reverse will rest with the individual units. Uniformity of practice cannot result under the co-operative system as this is generally understood, a system of horizontal co-operation.

A second method of combination is the direct absorption of the individual units to build what, in industry, is termed a merger. This at once gives the necessary control and offers an undoubted solution to the problem were this the only problem involved. It implies the complete industrialisation of tropical agriculture; and this is neither practicable nor desirable. It is impracticable, except in rare instances, because, even in a sparsely populated country the inhabitants have a vested interest in the land of which they cannot be deprived. It is undesirable because man does not live by bread alone and even the most backward of peoples have a claim, bearing now the sanction of the Covenant of the League, to the opportunity to raise themselves until they are capable of standing alone. The tropics are essentially agricultural and any policy involving the industrialisation of agriculture necessarily involves the reduction of the mass of the inhabitants to the status of landless paid labourers, whose only opening for advancement is to leave the land. It is needless to follow to its logical conclusion the effect of such a development in a country where industry offers little, or no scope as an alternative field for productive employment. *Si monumentum requiris circumspice*; the world has many instances to show.

There remains a third method by which combination can be effected; it is that which may be most aptly described as vertical co-operation and, in the agricultural field, its essence is to be found in the system prevalent in many parts of the continent under the name of metayage. The metayer system is a very old one and is found widely distributed. It bears a close resemblance to the Indian system known as 'batai.' As is natural with a system of this antiquity, it has taken many forms some of which are very degraded. It owes its origin, in all probability, to the absence of any free monetary system at a time when the exchange principle in common use was barter. It was a system of adjustment of the relations between landlord and tenant on a basis of kind. In its simplest form the rental is fixed at a percentage of the produce, the methods and class of cultivation being left to the tenant. As agriculture developed in complexity and cultivation became more and more a capitalistic venture, the metayer system developed a like complexity. The normal

tenant lacked capital and it became the custom for the landlord to supply the necessary stock and implements, receiving in return a larger fraction of the crop.

It is not possible to follow out in any detail the numerous variations of the system. That it is capable of abuse is undoubted as the history of 'batai,' could it be given, would indicate. But that abuse is traceable to a single cause. Under an increase of agricultural population sufficient to exert an appreciable pressure on the land, competition for tenant holdings affected adversely the tenants' bargaining power. Thus there arises the opportunity for absenteeism which is so common a feature of a landlord system wherever that system is found. Absenteeism strikes at the root of the metayer system which is fundamentally a co-partnership between landlord and tenant in which each shares in the labour production, shares its risks and takes his proportionate part of the reward.

The metayer system is a landlord system. The unit is such area as is the property of an individual. It suffers, as must all forms of enterprise which are based on individualism, from a lack of continuity. The parent who has made the estate his personal charge, gives way to the son who has no liking for the life agricultural. He becomes an absentee and the estate suffers. That, however, is an incidental disadvantage. The essential point is this; here is a system which affords opportunity, and provides the agent, for the control which has been shown to be necessary. The actual division of labour as between landlord and tenant will differ according to the various local conditions and, in determining the mutual responsibilities all the pertinent factors must be taken into account. Thus conditions exist where the major operations of cultivation, such as ploughing, might suitably be undertaken by power units and, in such cases, these operations become a function of the landlord. These operations are so conducted in the Sudan Gezira which affords an example of what is essentially a large scale experiment under metayer conditions for cotton growing.

For the purposes of tropical development it would seem necessary that the system should not be based on individualism. Thereby lack of continuity will be avoided. A further defect from which the system, as found on the Continent, suffers, will also be avoided. As long as the unit is a personal estate the financial resources depend on factors which have little connection with the agricultural requirements. Yet a third defect lies in the size of the unit which is usually too small for the control to be effective. All these disabilities are removed if the system is applied on a large scale by a company such as is the case in the Sudan. Policy will now be continuous, being no longer subject to unforeseeable and even vicarious interruption; financial considerations need not restrict area or cultural operations. The development of the tropics on such a basis gives other advantages besides these. A trained technical staff can be employed to interpret, and put into practice, the teachings of research; and, its cost entering into the costs of production, the magnitude of that staff will be determined on economic principles. The organisation of supplies of high grade seed, manures and so on, too, becomes possible and the produce can be handled and marketed in bulk. Adjustment between landlord, the company, and tenant, the cultivator, will not take the form of rent but of a proportionate division of the cash receipts. But beyond and above these advantages is a greater one still; the agricultural population retains a stake in the land and is saved from a future as landless wage earners.

Mature reflection only confirms the view that this third system of attaining combination offers the most satisfactory solution of the problem of agricultural development in the tropics. But facts have to be faced. This field of development is not a *tabula rasa* on which he who will may write what he chooses. In most tropical countries development is in progress, a progress which, in some cases can be reckoned in centuries. Systems have been established and vested interests have arisen which cannot be ignored. The practical question of establishing control must be considered in the light of the three systems of development outlined above.

The first system is that of the personal estate worked on the plantation basis. It, like the Continental estate worked on the metayer system, is based on individualism and suffers from the same advantages. It is, further, the employer of labour for a wage, and adequate labour is difficult to secure and, frequently, as difficult to retain. Here individualism is likely to remain too strong for the absorption of the independent units. The practical line of development would appear to be along co-operative lines. While this does not give control it is not entirely inoperative as the Dutch have shown in Java. Co-operation throughout an agricultural tract for the employment of technical advisers, for the improvement of the plant and for the preparation and marketing of the produce may accomplish much. Since the main interest of such estates lies in exchange cultures the market for the produce of which is overseas, the conditions for co-operative marketing are favourable. But there is one direction in which the metayer system may well be applied and that is in the solution of the labour problem. It should be possible, though the case will depend to some extent on the character of the crop, to arrange a system of tenancy by which a certain body of labour is kept on the estate. The tenants should grow on their holdings a certain area of the exchange cultures and not merely crops which satisfy their own personal requirements. For that purpose they would receive aid from the estate, either guaranteed seed, manures or even the major operations of cultivation; they would submit to

such control as may be desirable for the suppression of disease, and for their produce they would receive payment at a rate based on the price realised for the marketable produce.

Such a system is not unknown in practice. Lands are sometimes leased, as to cane farmers, and the produce is sometimes paid for on a sliding scale based on the value of the marketable product. But rarely, if ever, is the true co-operative spirit inherent in the metayer system called into play. No control is usually retained and assistance is limited to an advance of seed or cash. The tenant follows his own inclination and is too often content with the cash advance of which he cannot be deprived. The sliding scale, too, is often imposed from without when friction has arisen. The form only, and not the spirit, of the metayer system is adopted.

That such a system must be of slow growth is evident. With a backward labouring class such as may be said to be typical of the tropics, the co-operative spirit will be slow to develop. But it is essentially a system which lends itself to small beginnings; the introduction of a few selected men to tenancy on this basis, and the extension of the area under tenancy as opportunity offers. It would seem, however, to offer the most promising solution of the labour question which is bound to become of growing importance.

In the case of development by companies the same arguments apply, but combination should be more readily effected for there is not the individualism to be broken down. Technical supervision, too, can be more readily incorporated into the administrative machine while finance has not the same external limitations. In the other direction the policy of building up a tenantry will be identical.

Lastly, the third system, native production requires more detailed consideration. It owes its existence on an extensive scale to the action of Government in checking the alienation of land to foreigners. The unit of production is small; the producer is ignorant of any but the local routine standards of cultivation which, though they may sometimes be highly skilled as the result of generations of experience, may not be adapted to the needs of exotic exchange cultures nor recognise the risks to which these are exposed when grown on an extended scale. Contact with the market is maintained through a trading community having no direct interest in production itself and, from the purely business aspect, seeks to obtain its supplies at as cheap a rate as possible. There is no progressive indigenous element in the population to work for the advancement of agriculture or to exercise the necessary control.

In these circumstances the tendency has been to attempt to bridge the gap by official agency; on the technical side by a trained advisory staff and on the financial side by officially supported co-operative organisation. It must be evident that, while such a policy can do much, it cannot offer a final solution of the problem. The countries involved are vast and personal contact and demonstration in the cultivators' fields are the only means of effecting a real and permanent improvement of agricultural practice. The Agricultural Departments would require to be of a strength beyond any contemplated to effect this change. The charge against general revenue would be crushing. It would appear to be essential to devise some means of costing out the charge against the industry itself. But this is not all. Government has long exercised a control over plant and seed importation and has in a few cases extended that control in the case of specific and serious disease to the field. Such control, however, has rarely been effective for the rules are difficult to enforce with any available staff. A more fundamental objection to this form of control lies in this; an official organisation must be advisory and work through the good will of the agricultural community and this it cannot do if it is saddled with police work.

The solution appears to lie in this direction. The basic policy in these tropical areas is development through the indigenous systems, using and maintaining as far as possible tribal custom. Tribal custom recognises a chief at whose will, as representative of the tribe, the tribal land is distributed among members of the tribe. Here is an agent ready to hand already possessing many attributes of a controlling authority and capable of assuming more without any breach of that custom. He lacks, it is true, the knowledge, the experience of markets and, probably, the financial resources. But these are lacking in any indigenous agency at present in existence. If the policy of the Covenant is to be implemented, an indigenous agency has to be created and in the ranks of the tribal authorities it will be found with least shock to tribal custom. In the meanwhile development must proceed and, for this purpose, the deficiencies of this potential indigenous agent must be made good from without. This can be effected by corporations entering into agreements with the chiefs under which they provide technical advice and finance while, in return, they receive power to control, to prepare the produce, if this be necessary, and to market it. The adjustment as between corporation, chief and cultivator will, following the metayer principle, be made by a proportionate division of the proceeds on the basis of price realised. It should not be beyond the bounds of possibility to devise equitable terms which will at once give that security which will alone attract capital and impose the minimum of restriction on tribal authority; and, in defining these terms, Government is the agency which must see that the balance is maintained. Coupled with a suitable education for the chiefs, such a system would, in time, open up a wider field to the tribal ruling castes; something more than a future within the organisation of officialdom would be open to them, a future as active and essential agents of development. Again it must be a slow process but it is one which is calculated to further the

building up of a self-contained people capable of standing alone even though exposed to the pressure of a world demand for tropical products.*

V.

In the preceding article I have attempted to outline the path rationalisation must follow if the risks inherent in agricultural production under tropical conditions are to be reduced to a minimum, and the advantages of the additional stability accruing therefrom, to be reaped. It is the path which leads to the maximum control of those forces of nature which will yield to human endeavour. It is a long path and, as was indicated, progress along it must necessarily be slow. There is here no solution to the immediate and urgent problem set by the general depression which is the result of overproduction of almost every class of tropical product and aggravated by the urge to increased production, itself the result of a desire to create, through the opening up of tropical countries, an outlet for the industrial products of the home country. The problem of the risk to production which has been discussed and for which a rationalistic solution has been offered, is one that does not arise in industry. The problem of overproduction finds its counterpart in industry and industrial experience must be the guide to the methods. But there must ever remain in the background the need for securing stability in the productive processes themselves. Here the practical problem, owing to the international character of tropical agriculture, is less a question of adjustment of supply to demand than a question of how to survive in the face of the severe competition which overproduction has engendered. This is rationalisation in the narrowest sense of the word.

Considerable caution must, however, be observed in applying the experiences of industry to agriculture for there are certain fundamental differences which must not be ignored. Agriculture is not so flexible as industry. In the first place the application of science to agriculture is slower in yielding results and the function of science is somewhat different. In industry, science is a progressive force. Science has revolutionised many industrial processes in a short space of time and such revolutions are unthinkable in agriculture. The changes which have been effected in industry are of a nature which all producers must adopt or at once go to the wall. Science may, it is true, show the way to double or treble the crop; it may, as by soil infection with certain Leguminosae, show the way to grow a crop where previously growth was impossible, but its potentialities as a progressive force are limited. A large part of its effort, though none the less important on this account, bears a negative character, the maintenance of fertility and of health of the plant and the prevention of disease. In the words of the World Economic Conference, its efforts are largely directed to "securing the minimum waste." In the second place, the class of product is strictly circumscribed. Climate exercises a very rigid control and dictates what crop can, and what cannot, be grown and there is not freedom to transfer from one class of production to another as occurs in industry. In the third place many tropical crops are perennials and may take a number of years to reach the productive stage. Not only is it difficult to make a transfer when such crops are involved but output is not readily adjusted to demand.

As a result of these latter considerations the tendency in tropical agriculture has been for the producer of exchange cultures to rely on a single crop. He has, to use a homely phrase, all his apples in one basket to an extent not found in other enterprises. It is an unsound position financially, because he is exposed to the full force of the ups and downs which characterise every form of productive enterprise. It is unsound agriculturally not only because the extensive continuous areas of a single crop offer an optimum condition for the spread of disease, but because it neglects one of the fundamentals of sound agricultural practice, rotation. Rotations are no doubt difficult, where, as in tropical agriculture, perennial cultures constitute a large percentage of the cultivation, but their general neglect is thrown into relief in the case of cane by the Javan system which entails rotation and, generally, by the slow extension of the system of cover cropping which partakes, in its effect, of the nature of rotation. The magnitude of the financial effect which this dependence on a single crop produces may be illustrated by a comparison between the returns of typical companies concerned respectively with the production of rubber alone, tea alone and a range of products mainly tea, rubber and coconuts. The returns cover the last eight years.

	Rubber alone.	*Tea. alone*	*Rubber, tea and Coconuts.*
Maximum price £1 share ..	42/6	120/-	144/-
Minimum price £1 share ..	7/-	21/-	95/-
Ratio max. to min. ..	5.7 : 1	6.0 : 1	1.5 : 1
Maximum dividend ..	5/-	11/-	6/-
Minimum dividend ..	1/-	2/-	3/6

The above examples, to which many more might be added, are sufficient to show the degree of added financial stability which results from dependence on more than one crop. It is not forgotten that climatic considerations and the long period of growth of some plants impose a limit to the diversity of cultures which can be produced in any one locality. The solution here is to be found in the combination of different units in different tracts and in obtaining by this means the desired diversity of production. The solution

* The system here outlined is dealt with in greater detail in my book, *Land Tenure and Agricultural Production in the Tropics.*

here offered suggests a widespread organisation having the essential features of a holding company with its subsidiaries widely scattered throughout the tropics and engaged in different forms of production.

Here is a form of rationalisation capable of immediate application and for which the present period of depression is favourable in as much as it is during periods of depression that the danger of over-capitalisation is least in evidence. It is a form of rationalisation which finds its counterpart in industry but which should be more readily accomplished than in industry. In industry combination is usually accompanied by a re-distribution of production with a re-modelling of factory plant and even with the closing down of some of the producing units. The cost of installing new machinery and buildings and of writing off of disused plant is considerable; together they make the process an expensive one. There is little of this cost in agricultural combination. Except in the case of sugar, machinery which would become useless and require replacement forms an insignificant item in the capital cost. The factory in agriculture is coterminous with the field and production cannot be concentrated within the walls of a single building.

Science, again, plays as important a rôle in agriculture as in industry though, as has been explained, this rôle is somewhat different. Here the difficulty with the small unit of production has been to devise means whereby the necessary staff may be employed and given adequate contact with the practical aspect; for the sciences with which agriculture is concerned are so numerous and specialised that an adequate staff is necessarily expensive. This difficulty is now removed. A company or corporation on the scale here indicated, and with the financial stability conferred by the variety of its interests, is in a position to employ an adequate staff. More than this, such a body is in a position to derive the fullest benefit from that staff. Many of the problems of agriculture, and not the least important from the practical aspect, are common to crops in general. The solution to these may be found by a study of the behaviour of different plants under a wide range of conditions. The utility of a scientific staff able to range over the wide field which the interests of such a body cover, can hardly fail to exceed the utility of that same staff confined to one set of conditions and a single crop.

The argument here advanced may, perhaps, be made clearer if the subject be approached in a somewhat different manner. It is common experience that there is a broad gap to be bridged between a scientific discovery and its commercial application. The bridging of that gap takes time, as witnesses the history of synthetic indigo. The whole process is scientific and technical; it starts with pure research, is continued by applied research and ends in practice. The passage is so gradual that it can rarely be said that here pure research ends and applied begins, here applied research ends and practice begins. Research, even fundamental research, which has more than an academic function, must feel its way towards practice, and practice, when scientifically controlled, must feel its way towards research. This is particularly true in agriculture for, as already noted, science plays a definite, if negative, rôle in maintaining the standard of agriculture. Without it, there will be regression. However that may be, the results of fundametal research are not necessarily, in fact rarely, directly applicable in the field. The field is not a factory or a test-tube in which the conditions can be standardised. The results must be tested out in each locality, it may be in every field. Here is a wide field of investigation requiring a trained staff with access to the fields in which the plant is growing under commercial conditions. Intensive research, research into the more fundamental problems, may, probably will, remain divorced from specialised commercial interests, under the control of Government or other non-commercial agency. But such research will fructify more readily when there exist agencies whose function it is to interpret its results under the wider range of conditions prevailing in commercial production.

These, then are the lines on which rationalisation of tropical agricultural production may be expected to proceed. Like all rationalisation, it is a diverse process. Above, it is a process of combination of existing units to form corporations of sufficient magnitude to employ the necessary technical staff as a permanent overhead charge; with a sufficient diversity of interests to create the maximum financial stability. Where this is not possible, combination of a co-operative basis, if less effective, has undoubted possibilities. Below, it is a system of devoluted cultivation on the metayer basis. Complete rationalisation on these lines is not a matter of today or tomorrow. It will be a slow process in which progress will be greater in one direction than another. It will differ, too, in different circumstances for tropical agriculture has already proceeded along different lines and the starting point is nowhere identical. If a cut and dried scheme be not possible, it is possible to offer a clearly defined goal towards which rationalistic effort may be directed with great advantage to the stability of the industry and with great benefit to the indigenous populations concerned.

And what of the disadvantages? For any scheme must be judged not merely on its potentiality for good but on its potentiality for avoiding evil. Industrial rationalisation is not an unmixed blessing and may be the opportunity of much abuse. Carried to extremes, combination leads to monopoly and uncontrolled monopoly develops a condition in which efficiency in production ceases to be a primary consideration and the financial aspect dominates. Such a situation can

hardly arise in tropical agriculture. Monopoly is most readily established where the capital outlay in plant is so great that only large units of production are possible or where the processes are highly technical and protected by patents, neither of which conditions apply to agriculture. The corporations here conceived are interested in a wide range of products and nothing short of world-wide combination can create a monopoly comparable to an industrial monopoly. Individualism may be reduced but can hardly be suppressed to extinction. It will remain as an ever present check to monopolistic abuse.

A further, and by no means the least, of the dangers of large scale production is stagnation. The cost of change of plant and of the replacement of old stock by new, is considerable when new models or new processes are introduced and the buying in of patents merely to suppress them and thereby save these costs is not unknown. Further, combination carried to the extent of the production of one or, at most, a few units reduces the free market for the services of scientific and technical men. A time comes when a shortage of such men arises since the prospects of a profession are lacking. The present shortage of trained men, especially biologists, of which so much has been heard in recent years, does not arise from this cause. That shortage is principally due to the fact that there is not, and never has been, a free market for such services. The creation of a number of corporations of a size capable of carrying the necessary staff, scientific and technical, will do more than any other development to establish a free market which is the basis of all professions. If the conditions prevent the creation of a monopoly position, that healthy rivalry which leads to progress will arise and ensure the employment of such services to the full economic limit.

Lastly, not the least of the disadvantages of industrial rationalisation in a country like England with its large industrial population, is the disturbance it creates in the labour market. Here the population is none too mobile and is entirely dependent on industrial employment. This difficulty hardly exists in the case of agricultural development in the tropics. Here the common complaint is of a shortage of labour; a shortage which is largely due to the fact that though labour is available it is not entirely dependent on wage employment for its continued existence. The tropical labourer, with his low standard of living and few wants, frequently prefers a life of ease, consuming what he himself produces, to a life of toil which will provide him with additional comforts for which he feels no urgent desire. In fact, the metayer system developed with sympathy and understanding, offers a real and better channel by which the agricultural labourer in the tropics may be led to a higher standard of living than the channel provided by paid labour, or the channel provided by independent peasant holdings.

TROPICAL SOIL SURVEYING.

PART II.

(B) Specific Surveys.

By F. Hardy.

In Part I of this article, which appeared in the last issue of *Tropical Agriculture*, were briefly described the objects and main methods employed in soil-surveying undeveloped tropical areas by simple reconnaissance and botanical exploration. There the object is not so much to gain accurate knowledge of the agricultural potentialities of an area, but rather to detect and to map the various regions where different types of soil occur and where different sets of growth conditions, as indicated chiefly by the natural flora, are displayed. The next stage in development is usually some sort of field experimentation. Certain localities are selected for clearing and planting, and careful observations are made as to the behaviour of specific crops under the various growth environments, and under various systems of agriculture or sylviculture. In areas that have already been exploited by native inhabitants or by early settlers, much experience may already have been acquired, and the reputation of different soil-types and different localities will doubtless have been thoroughly established. The soil surveyor's investigations will now chiefly concern the characterization of both the soils and the environments, by methods which preferably give numerical expression to the contributing factors controlling soil quality and plant growth. Since it is necessary in such investigations to study the soil in relation to the plant, the methods of soil examination now to be employed may best be described as physiological and ecological in aspect.

III.—The Physiological-Ecological Soil Survey.

Where comparisons are to be made between regions or localities for which accurate yield figures and observations on the behaviour of specific crops are not yet fully available, or are still in process of compilation, the *soil profile method of soil examination* offers a useful means of approach, particularly if it includes a preliminary laboratory study of representative soil samples collected from the various horizons, zones and layers which deep sections expose.

The Soil Profile Method as applied to the Physiological-Ecological Soil Survey.

A procedure which gives satisfactory results is described as follows: Sites representative of the regions or localities which are to be compared are selected, and pits, four, six or ten feet deep, are dug at each site. The pits should be wide enough to allow an observer to view a clean vertical section down to the lowest depth, and to collect soil material without undue hindrance. The clean face of the section should be well lighted, but should not be exposed to direct sunlight nor

to strong shadows. After some concentrated inspection of the profile, differences in appearance will become evident, and it will usually be easily possible to mark out the section into horizontal layers based solely on colour and structure differentiation.

Where feasible, the section should be exposed right down to the parent rock. Frequently, even in the tropics, this may be achieved in a pit six feet deep. In the majority of tropical crops, however, the main feeding roots occupy the soil extending down to the three or four-foot level, although some roots may penetrate very much deeper. Thus, much valuable information of the soil conditions may be gained by an examination of comparatively shallow profiles. On the other hand, deeper pits favour the collection of information which has bearing on soil genesis, that is, on the relationship between a soil and the parent material from which it is derived. Unfortunately, the digging of deep pits is a tedious and lengthy process, the difficulty increasing greatly as the depth of the pit exceeds five or six feet. In practical soil-surveying, ten or twelve-foot pits are usually out of the question. Occasionally, river banks and recent excavations for road-making or house-building may furnish a suitable deep soil section within a selected site, but generally recourse must be made to a soil borer, which may be used to obtain samples of the soil at depths greater than six feet by applying it to the floor of a suitably wide pit. The best type of soil borer for this purpose is a screw auger of large diameter, or a flanged implement such as is employed for boring holes to receive fence posts. Great care must be exercised in attempting to procure material representative of the deeper layers, particularly in the vicinity of the parent rock, where rapid changes in mineralogical and chemical composition may occur within a very small distance.

Each layer of a soil profile should be fully described, its thickness measured, and a representative sample collected and labelled. Some difficulty arises in the choice of suitable terms for describing colour, variegation, structure, texture and degree of soil compaction. There is urgent need for standardization in the nomenclature of these terms. A suitable colour chart for aiding soil description is especially required. The personal factor in judgment varies very greatly between individual observers, and it is necessary often to postpone the assignment of colour value and texture to a soil until it has been brought to an air-dry condition, and suitably pulverized and sifted. A procedure which has given some satisfaction at the Imperial College of Tropical Agriculture is to mix finely-sifted samples of the profile soils with cellulose varnish ("Necol"), and to paint the mixtures on to a card, ruled to scale and lined with parallel columns in which the values of the various factors (reaction, texture, organic matter content, &c.) measured in the laboratory, may subsequently be depicted in water-colour washes based on arbitrary scales of standards.

In the laboratory, the profile soil samples are air-dried and passed through a 2 mm. sieve. They are then submitted to quantitative examination for the purposes of broad characterization. The main soil factors which may rapidly be assessed in the laboratory are reaction, texture, content of organic matter and of nitrogen, carbon-nitrogen ratio, readily-available water-soluble plant nutrients, and rate of solution of the less soluble, potential plant nutrients.

Reaction (pH value) may rapidly be measured by the quinhydrone electrode, or by the use of indicators. *Texture* may be approximately measured by determining the moisture content at the point of stickiness (M.P.S.) and correcting the result for sandiness by determining also the percentage amount of fine and coarse sand, by a conventional water-sedimentation process. The value, "Index of Texture" (I.T.), is derived from these two quantities by applying the formula; I.T.=M.P.S. minus per cent. sand/5 (*see* references [1]). *Organic matter and carbon contents* are easily measured by a wet-combustion method.[2] *Nitrogen contents* may be determined by the well-known Kjeldahl procedure. *Nutrients* may be assessed by an electrical conductimetric method,[3] whose value in rapid soil analysis has been clearly indicated and stressed in an article by Mr. C. H. Wright, which appeared in the last issue of this *Journal* (Vol. VII, No. 9). The technique need not therefore here be further described.

All the methods mentioned above may be satisfactorily applied under the supervision of a competent soil chemist by assistants having little previous technical knowledge or training. Thus, we have been able at the Imperial College of Tropical Agriculture during the past two years to describe, sample and examine in the ways outlined above, some 200 soil profiles, involving 1,880 separate soil samples, representative of areas under forest, cacao, coconut and sugar-cane. In many of these cases, "good" sites were contrasted with "bad," according to the opinions of planters or based on approximate yield figures. As examples of the kind of results that may be accumulated by these methods, and their usefulness in gaining insight into the relative importance of the various soil factors that control plant growth a table of typical values is here presented.

The main conclusions to be derived from the laboratory data are given in a series of notes that follow the table. It will be observed that most of the distinguishing features concern mineral nutrition and the factors (such as soil organic matter undergoing transformation) which decide the concentration of nutrients in solution, and the rate at which the soil delivers soluble matter so as to maintain this concentration at a suitable level.

Examples of Soil Profile Data.

Description of the Profile.	Lower Depth.—(ins.)	"Good" Site. I.T. *	Reaction (pH value).	O.M. per cent.	Per cent. N.	C/N Ratio.	Readily Available Nutrients. †	Rate of Soln. †	"Bad" Site. I.T. *	Reaction (pH value).	O.M. per cent.	Per cent. N.	C/N Ratio.	Readily Available Nutrients. †	Rate of Soln. †
(A) Cacao Soil Profiles—(*Campbelltown Estate, Tobago*).															
1. Humic topsoil, root mat ..	2	53	7.8	11.6	0.61	11.0	656	638	45	6.5	4.3	0.34	7.4	182	197
2. Humic subsoil ..	6	40	7.7	5.6	0.38	8.8	398	366	44	6.7	3.5	0.32	6.5	176	199
3. Slightly humic subsoil ..	18	30	7.2	2.0	0.17	7.0	210	144	40	6.8	1.7	0.12	5.7	87	50
4. Tawny drab clay ..	32	26	6.9	0.5	0.06	5.8	85	50	39	6.7	0.7	0.07	5.8	98	38
5. Stony tawny clay ..	48	24	6.6	—	—	—	80	85	30	6.7	—	—	—	108	68
6. Soft, rotten schist rock ..	60	23	6.9	—	—	—	78	84	33	6.6	—	—	—	100	58
7. Harder rotten schist ..	72	26	7.0	—	—	—	77	88	36	6.4	—	—	—	95	0
(B) Coconut Soil Profiles—(*Adela Estate, Trinidad*).															
1. Humic topsoil, friable ..	3	47	6.3	5.8	0.36	9.3	185	66	13	5.9	2.4	0.14	9.9	60	46
2. Compact, slightly humic subsoil ..	6	42	6.0	2.7	0.24	6.4	91	25	12	5.7	1.6	0.12	8.1	54	14
3. Ditto ..	12	40	6.1	2.8	0.20	8.3	71	30	11	5.7	1.2	0.10	6.8	47	9
4. Slightly mottled soil ..	24	33	6.6	0.6	0.07	4.6	90	7	16	5.6	0.8	0.08	5.7	26	5
5. Ditto ..	36	34	6.5	—	—	—	344	54	8	5.6	—	—	—	25	3
6. Pale-coloured soil ..	48	34	6.1	—	—	—	616	75	11	5.8	—	—	—	28	2
(C) Sugar-Cane Soil Profiles—(*Caroni Estate, Trinidad*).															
1. Friable topsoil ..	5	20	7.1	1.4	0.10	7.4	90	35	39	5.4	1.7	0.15	6.7	99	41
2. Compact subsoil ..	10	19	7.5	1.0	0.09	6.8	71	68	37	6.1	1.3	0.12	6.5	50	29
3. Speckled subsoil, drab colour	18	21	7.5	0.8	0.08	6.2	66	56	40	5.8	0.8	0.09	5.4	48	20
4. Mottled subsoil ..	24	27	7.3	0.4	0.04	5.4	66	39	40	5.6	0.4	0.06	4.0	92	41
5. Ditto	36	12	6.9	—	—	—	47	15	42	5.4	—	—	—	38	12
6. Ditto	48	18	6.0	—	—	—	—	—	39	5.7	—	—	—	—	—
7. Grey soil, coarsely mottled	60	10	7.1	—	—	—	—	—	39	5.8	—	—	—	—	—
8. Grey soil	72	14	7.0	—	—	—	—	—	42	5.9	—	—	—	—	—

* *Index of Texture*:—above 55, clay; 54-55, heavy silt; 44-40, fine silt; 39-30, heavy loam; 29-20, light loam; 19-10, sand; 9-0, light sand. (Suggested arbitrary scale.)

† *Nutrient Values*.—The figures are electrical conductivity values $\times 10^{6}$ (millionths of one mho), of extracts prepared from 1 part of soil to 5 of pure water, at 30°C. (*a*) after 21 hours, and (*b*) after 7 days standing. The first (*a*), yields a measure of the easily-available nutrients, and the second (*b*), *minus* the first, yields the rate of solution of potential nutrients.

Notes.

(*A*) *Cacao Soil Profiles.*

The "good" soil is slightly more sandy in texture, less acidic in reaction, contains more organic matter and nitrogen in the upper layers, is very much richer in available plant nutrients at the time of sampling (Jan., 1930), and shows a very much higher rate of solution of potential nutrients, than the "bad" soil. Moreover, the C/N ratio of its organic matter component is greater throughout the profile. This, together with the large differences in nutrient values, particularly contrast the "good" cacao soil with the "bad."

(*B*) *Coconut Soil profiles.*

The trees were the same age (18 years) at the two sites. In the "bad" soil, the trees had recently died of "wilt." The "good" soil is much heavier in texture, somewhat less acidic, contains about twice as much organic matter and nitrogen in the various layers, and contains a higher concentration of available plant nutrients and a higher rate of solution (especially in the lower layers), than the "bad" soil. There is no significant difference between the C/N ratios. The most striking feature of the "good" soil is its relatively high nutrient status in the lower layers.

(*C*) *Sugar-cane Soil Profiles.*

The "good" soil is much more sandy in texture, much more alkaline in reaction, and somewhat superior in nutrient status, as compared with the "bad" soil. The contents of organic matter and nitrogen are slightly higher in the "bad" soil, but the C/N ratio is a little less. The "bad" soil profile showed, by a marked blue mottled appearance, the effects of poor drainage and occasional waterlogged conditions below the 10 inch level. Similar indications appeared only below the 26 inch level in the "good" soil.

Conclusions.

The main features of "good" and "bad" cacao, coconut and sugar-cane soils, as portrayed by the figures contained in the above table although they are somewhat extreme, are generally characteristic of "good" and "bad" areas of the agricultural lands of Trinidad and Tobago, at least in-so-far as our present limited experience applies. The results at least suggest that ecological soil-profile studies of the kind described in this article furnish some evidence of the nature of the differences which contrast "good" from "bad" soils growing crops of divergent sorts.

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CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Italian Linseed Oil Industry.

Italian linseed produces a good yield of an oil of exceptionally high grade, especially suitable for medicinal use. The demand for a lower grade industrial oil is satisfied by the use of large quantities of imported seed. Ninety per cent. of the imported seed, which amounts to more than twelve times the home production, is grown in British India. It is necessary to subject the lower grade oil to a refining process before placing it on the market.

Extraction is carried out in two stages. A higher grade product is first obtained by cold pressing which gives a 30 to 32 per cent. yield. The residue is extracted by solvents or by hot pressing when a further yield of 12 to 13 per cent. of an inferior oil is obtained.

Quantitative extraction methods are being sought, as the residual cake cannot be used as fodder. At present, the cake, which contains 1.2 to 5.2 per cent. of phosphate and 1 per cent. of potash is being used as fertiliser.—(*Ind. Eng. Chem.*, New Ed., Vol. VIII, No. 3.)

* * *

The British Nitrogen Industry.

The report of the British Sulphate of Ammonia Federation for 1928-29 shows that the production of nitrogenous compounds in England is increasing steadily. The period 1928-29 showed an increase of 22.5 per cent. on the previous similar period. Consumption of these products is increasing at a much slower rate, showing an increase of only 14 per cent. during the same period. Greater increases are expected, however, in following years. A critical period for the industry is prophesied which can be overcome only by restricted production or by extensive advertisement to increase selling. With increased production the price of neutral sulphate of ammonia has decreased from £19 6*s.* 6*d.* per ton in 1918-19 to £8 9*s.* 6*d.* during the past year. Further reductions are predicted during the present period. The low price has seriously affected the gas companies which prepare by-product ammonia. A further fall may make the recovery process uneconomic.

In spite of such forebodings, plants are being erected for the manufacture of nitrogenous compounds in England by the Imperial Chemical Industries. It is probable, however, that their confidence in the market will be realized, for undoubtedly in the near future every agriculturist will be forced by economic conditions to use artificial fertilisers. It is claimed that the erection of the new plant will enable the Imperial Chemical Industries to supply the entire British Empire with nitrogenous compounds and thus render her self-supporting.—(*Ind. Eng. Chem.* New Ed., Vol. VIII, No. 1.)

PANAMA DISEASE RESEARCH.

A Discussion of the relation of Results obtained to Field Conditions.

By C. W. Wardlaw.

1. Introduction.

Although it was felt, when the subject of Banana Research at the Imperial College of Tropical Agriculture was first being considered, that the solution to the problem of Panama Disease most probably lay in the production of an immune variety, it was also thought that the disease i self required further investigation. Accordingly the services of a pathologist were included in the Research Programme. The observations submitted here, based on two years work in the field and in the laboratory, lend confirmation to the suggestion that the disease aspect of the problem was worthy of further consideration.

2. Preliminary field observations.

The re-investigation of the problem was commenced in 1928 when the writer made a comprehensive tour round the important banana growing areas of Central and South America and the West Indies. A similar but independent tour was also made a little later by Dr. McGuire. The general idea current at the time was that the extensive abandonments in Central America had resulted entirely from the spread of Panama Disease—an idea to which neither the writer nor Dr. McGuire could assent after personal contact with the areas in question. The results of field investigations have been set out in full in the Empire Marketing Board Report No. 20 [4], and only the general findings need be considered here. The salient points regarding the abandonment of banana lands in Central America may be briefly re-stated as follows :—

1. Under the extensive system of agriculture adopted in opening up large tracts of new land considerable areas were frequently planted which were quite unsuitable for the continuous cultivation of the Gros Michel banana. The rapid decline in production soon led to the abandonment of such areas.

2. At an early stage in the development of the industry the great value of alluvial soils for banana growing was recognised. Such alluvial lands, however, show great variation both in soil composition and in drainage facilities. In the complete absence of tillage, humus maintenance, &c., the less favourable types of alluvial soils, whether stiff acid clays or open sandy deposits, usually showed a decline in production after a number of years of continuous cropping. Instances were also seen where excellent soils gave insufficient production and had to be abandoned because their situation did not permit of adequate drainage. Of recent years, however, such areas have frequently been reclaimed by the installation of extensive drainage systems and production has proved very satisfactory. Where the soil is essentially good in its natural state and in a situation favourable to drainage, continuous high production has been the rule over 20 or more years and disease has been negligible. On the other hand, on soils which showed some defect in fertility, either innate or on account of situation, lower production over a shorter period was the rule while the incidence of disease was much greater. Abandonment from the commercial standpoint was not necessarily, therefore, a measure of the intensity of the disease ; it was simply an indication of inadequate production in relation to cost of upkeep. It has been seen that this inadequate output may be attributed to constitutional unsuitability of soils, to deterioration of mediocre soils in the absence of true cultivation, and to actual disease. To the man in the street, however, "abandonment" and "Panama Disease" or "disease" in Central America are practically synonymous, the tendency being to assign all failures to any important contemporary disease. The problem has been further complicated by the fact that good areas have not infrequently been planted with diseased material.

3. Taking actual production of fruit as the final criterion, the problem thus resolved itself into two distinct but probably inter-related aspects, namely the treatment of disease and the maintenance of fertility relative to the rather exacting requirements of the Gros Michel banana.

4. These observations, however, present only one aspect of the problem. It has long been known that, while the Gros Michel banana is susceptible to Panama Disease, other varieties, such as the Lacatan and Giant Fig, are definitely immune, and will grow and produce fruit on areas where the Gros Michel has already succumbed to disease. Such susceptibility or immunity is a function of the genetic constitution of the individual variety. The problem is further complicated by the fact that the Red Banana, which is usually highly resistant, sometimes succumbs to the disease. The fundamental problem with which the pathologist was faced was to determine whether the well-known susceptibility of the Gros Michel was constant for all external conditions, or whether it might be possible to delay or prevent infection by improving the adverse soil conditions under which the banana is frequently grown.

3. Experimental Observations.

In the light of the general ecological evidence set out above, the investigation was continued by making detailed observations on sucker and root infection under controlled experimental conditions. From the data accumulated during these studies the case for conditional infection may now be briefly considered.

The following facts have been ascertained [5] :

1. Suckers grown in well aerated, moist soils, heavily inoculated with *Fusarium cubense*, do not become diseased by way of the basal cut end or through superficial wounds, including old leaf bases.

2. Such possible infection courts are only invaded by hyphae to a slight extent, deeper penetration being prevented by the development of suberised cambiform barriers. It has been amply demonstrated that the latter cannot be penetrated by the hyphae of *Fusarium cubense*. These protective barriers are developed in relation to wounding or to the diffusion of fungal secretions and are the result of active growth changes on the part of living parenchymatous tissues. The important external factors controlling such activities, *i.e.*, cell division and cork deposition, include moisture and oxygen supply. Other factors may also be involved. Thus any external factors which militate against the rapid deposition of suberin and the growth and division of tissue will tend to promote infection. Water-logging and inadequate aeration at the time of wounding may be cited as examples of external conditions inimical to the formation of these protective barriers.

3. With regard to the operation of such adverse factors, it has been found that many of the soils on which the cultivation of the Gros Michel has been attempted, especially untilled virgin soils, suffer from inadequate aeration and from adverse water relations.

4. Under conditions favourable to wound-healing, vessels which have been cut through or injured are penetrated by hyphae to a slight extent only. The presence of wound secretions, together with a collapse of vessels induced by the active expansion of adjacent parenchyma, effectively close this source of sucker infection.

5. Sucker infection appears to be principally of lateral origin, taking place either by way of the root bases, or through the agency of boring organisms. Leaving the latter aside, root-base penetration may therefore be regarded as the critical stage in the development of a significant infection of the sucker. This leads to a consideration of root infection.

6. It has been shown experimentally that roots grown in heavily inoculated soils which are well aerated and kept uniformly moist, do not become diseased after 40 days. This is true of acid, neutral and alkaline soils.

7. Variation in the supply of soil moisture, such as that caused by the drying out of an open soil, or by the introduction of a plasmolysing agent, leads to root disease.

8. Such root disease may be slight or extensive. Where the shock sustained has not been excessive, the healthy portions of the root develop protective suberised cambiform barriers by which deep fungal invasion is prevented.

9. Inadequate soil aeration or carbon dioxide vitiation also pre-dispose to root disease, probably in relation to the inhibition of adequate suberisation. Ecologically, it has been found that this factor is important in heavy and compact untilled virgin clay soils, and in soils subject to water-logging.

10. Penetration of the sucker through exposed root-bases is prevented under favourable conditions, by the secretion of wound gum, as well as by vessel collapse and the occupation of vessel cavities by tyloses.

11. Significant infection of the sucker takes place when external conditions have been favourable to the development of a marked amount of root disease close to the root base. Under certain conditions the infection may follow the track of boring organisms.

12. Once the hyphae of *Fusarium cubense* have reached the sucker stele, their further spread through the sucker appears to be inevitable.

13. The inoculation of pseudo-stems, petioles of leaf blades never leads to an extensive infection.

When these observations are taken collectively, the case for conditional infection of the Gros Michel by *Fusarium cubense* appears to be definitely established, since, under favourable soil conditions, root disease does not take place, and all of the several infection courts can be protected against deep fungal penetration. Thus one might postulate that the ideal banana soil, even though inoculated with *Fusarium cubense*, would, under suitable climatic conditions, support the Gros Michel banana in a wilt-free-state. While such soils do exist, the majority of those on which the cultivation of the Gros Michel has been attempted show some defect in fertility, water relations being frequently unfavourable. The practical aspect of the problem, however, is concerned with broad results rather than detailed experimental considerations. Thus, while strong evidence for conditional infection has been adduced, it remains to be seen whether adverse field conditions can be modified by simple means to permit of the functioning of the several protective mechanisms.

4. Extension of Experimental Results to Practice.

The observations submitted in the previous section indicate that infection of the Gros Michel by *Fusarium cubense* is a conditional infection, and that, given sound planting material, soil in good heart and possessing adequate water relations, Panama Disease might reasonably be expected to play a less important part in reducing the production of fruit. It remains for us to consider the application of these results to field practice. Two aspects of banana production must be considered, namely (1) the extensive system found in Central America, where large acreages are involved, and where no detailed soil treatment is practised, and (2) the intensive system in Jamaica, where acreage is more limited, and where some measure of detailed soil treatment is applied.

1. Central America

In Central America and Colombia,* soils ideally suited in their natural state to the Gros Michel occur in considerable areas. Their

* No Panama Disease has been reported from Colombia.

records are significant. Continuous high production has been the rule during 20 or more years, while Panama Disease, though prevalent in adjacent less fertile areas, has been at a minimum or absent. Any form of detailed cultivation on such soils is quite unnecessary. Such completely fertile areas, however, constitute only a portion of the total area on which the cultivation of the banana has been attempted. The major portion consists of soils which show some defect in fertility, and which would undoubtedly respond to appropriate treatments. These include (i) improved drainage, local and general; (ii) increased aeration; (iii) liming; (iv) maintenance of an adequate humus supply in relation to nutrition, conservation of moisture and drainage.

It is not necessary here to enlarge on these four aspects of soil improvement. The need for them is amply borne out by general field conditions, soil inspection and chemical analyses[3] while the stature and productivity of the Gros Michel and the incidence of Panama Disease afford strong ecological corollaries. The important question to be considered is whether ameliorative measures can be carried out under existing economic conditions. As far as the near future is concerned, the answer is in the negative. Soil changes such as improvement of tilth, aeration and the neutralisation of acidity by liming, take place slowly, and leaving aside drainage operations, which recently have received a considerable amount of attention, several years of assiduous labour would be required before significant results could be obtained. As the areas involved are very extensive, only highly organised mechanical tillage would be of any real service. Apart from the cost of machinery the introduction of such methods into Central America would present great difficulties, because the population is entirely untrained to this type of agriculture. Further, as labour is both scarce and costly, and as several years work would be required to give these suggested improvements a fair trial, it seems unlikely that detailed agriculture will receive much attention as long as the supply of unexploited virgin land holds out, or as long as there is the promise of an immune banana to replace the Gros Michel. Some minor attempts at detailed soil treatment have been made in Central America, and, as far as one can gather, they met with a measure of success; costs, however, were prohibitive.[2] Whenever thorough-going agricultural methods are applied to the extensive alluvial areas in Central America there is little doubt that they will be attended with remarkable success. Already an approach to more rational soil treatment can be seen in the reclamation of abandoned areas by extensive drainage schemes. In the early days of the industry areas were sometimes planted where adequate drainage had not been provided. Other areas subject to flooding as the result of rivers overflowing or changing their course, had to be abandoned on account of water-logging. Of recent years, however, by the installation of extensive drainage schemes, some of these areas have been reclaimed, and are now in a state of high production. The further improvement of soil conditions by the institution of detailed cultivation is, however, unlikely at the present phase.

2. Jamaica.

While, at the present time, the extensiveness of possible banana lands on the mainland precludes any attempt at detailed cultivation, the more limited supply of suitable land in Jamaica is leading to a replacement of the extensive system by the intensive system. As a result, sound tillage is undertaken on the best properties, and soils are beginning to receive detailed treatment according to their requirements. Much, however, remains to be done. Here again the feasibility of promoting soil fertility with a view to controlling Panama Disease has to be considered. The improvements suggested fall into the four categories already mentioned. It must be admitted that the general applicability of a soil improvement scheme involving extra expense over a number of years is, from the present commercial stand-point, doubtful,* and current opinion favours the view that the solution to the problem lies in the production of an immune banana. While this may be so, the commercially-approved immune banana has yet to be obtained, and, as production of fruit is the desired end, there is no doubt that appropriate soil treatments would result in increased output. The economic aspect is a matter for expert local investigation. Whether the problem is solved by the substitution of an immune variety or not, the need for soil amelioration should certainly not be neglected since production from immune varieties will also be favoured by the application of suitable measures. A good example of what can be done in this respect is provided by the Banana Industry in the Canary Islands, where untreated soils are essentially poor.[1] Again in Jamaica and other West Indian Islands, the need for alternative crops has frequently been stressed. The search for a rotation in which soil amelioration could be effected by the cultivation of alternative crops would not only contribute to the question of improved banana cultivation and the controlling of Panama Disease, but other useful ends would also be served.

The difficulties of such an undertaking are appreciated. It is also realised that these field aspects of the problem lie more within the scope of the practical agriculturist than of the

*At an earlier stage in the investigation[4] the writer expressed the view, based on field evidence, that by suitable soil treatment the disease might be held in check, and was hopeful that something might be done to mitigate the severe losses sustained by planters. Further work has shown that while this view has been scientifically substantiated, the expenses involved in producing the necessary soil changes are, unfortunately, likely to prove uneconomic.

pathologist. Since they are the logical extension of the detailed pathological investigation which has been carried out, however, it has been thought fit to discuss them here in a provisional manner.

In conclusion the writer wishes to express his thanks to the Principal and Members of the College Staff for the kind assistance invariably extended to him during the course of these investigations. In particular he is deeply indebted to Professor H. R. Briton-Jones for his valuable discussion of mycological aspects of the problem at all times, and to Professor F. Hardy for much useful information on soils.

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A NOTE ON *Alabama Argillacea.*

A PAPER entitled "*The mystery of Alabama argillacea*" by G. N. Wolcott (*American Naturalist*, No. 684), discusses the question of the source of the annual infestation of cotton worm in the Southern States of America, and also deals with several other points of interest in connection with this important economic insect.

In the Southern States a succession of waves of caterpillars appears annually in the cotton growing districts, and then ceases. The emerging moths migrate northwards in the autumn and feed on grapes and other ripe fruits in northern Ohio. A few weeks later swarms of moths are reported round electric lights even as far north as Canada. This habit, as the author says, "represents as futile and self-destructive a gesture as the Children's Crusade." Earlier investigators were unable to find any place in the United States where *Alabama* hibernated, and it gradually became clear that the first outbreak in summer is always an entirely new invasion from the Tropics.

This raises the question of where in the Tropics does *Alabama* occur the whole year round, and why, if such a place exists, do the moths fly north? The evidence, so far as it exists, indicates that in the Lesser Antilles, there is, each year, a new and separate invasion from the south. The writer had the opportunity of observing the habits of the cotton worm in St. Vincent from 1915-1920. The situation there is as follows:—The infestation always begins on or near a certain estate on the Windward Coast. Eggs of *Alabama* can usually be found at the time the plants are just coming into flower, but in most years they are heavily parasitised from the first by egg parasites, some of which also parasitise the eggs of *Calpodes ethlius*—the arrowroot worm. Since arrowroot provides a continuous supply of food for *Calpodes*, this crop may be regarded as a more or less permanent parasite reservoir. In addition, St. Vincent is an island of heavy rainfall, and the vegetation is luxuriant for most of the year, so that there is usually an abundance of parasites. In certain years, control by egg parasites at the commencement of the attack is ineffective, and a severe outbreak is experienced all over the island. The attack moves all round the Windward coast and finally gets round into the fields on the Leeward Coast. A severe outbreak of this kind happens about every four or five years.

While, however, the outbreak definitely originates from some region south of St. Vincent, it is quite possible that the insect breeds to a certain extent on the semi-wild Bourbon cottons which are sporadically distributed over the island, though most of these cottons have now been eradicated. The writer discovered in 1923 that the cotton worm could also breed on *Thespesia populnea*, a tree which is abundantly distributed throughout the Tropics of the New World. It is more likely, however, that the moths which start the attack in St. Vincent come from some cotton-growing region further south.

Such a district is provided by the large tract of cotton country in North Brazil, in the States of Parahyba, Rio Grande do Norte, and Ceara, and we may provisionally advance the hypothesis that the attacks in the Lesser Antilles are due to big migrations of moths from North Brazil. This raises the further question of where the infection in North Brazil comes from. The writer was recently informed by Dr. O. Lamartine of Natal, Brazil, that in the State of Rio Grande do Norte the attack begins in the south and works towards the north. Wolcott, however, in the paper before mentioned, presents evidence to show that in Peru there is a striking, but reversed similarity to the habits of the moth north of the Equator. There does not appear to be any evidence as to where the attacks come from in the extreme south of Brazil, in the State of Sao Paulo, but it is probable that the moths come from the north. Wolcott suggests that the moths impelled by the oncome of cooler weather south of the Equator are responsible for the first generation which appears in the West Indies and United States, and that the first mildly cool nights in Haiti and Texas are responsible for starting the reverse flights of moths in the direction of Peru. It may well be that there are big migrations from south to north and *vice versa*, in response to a particular set of meteorological conditions. Exact observations in Brazil should enable this important point to be settled, as well as the rôle played by *Thespesia populnea* as a secondary food plant.

S. C. H.

TROPICAL WORLD NOTES.

PREPARED BY THE IMPERIAL DEPARTMENT OF AGRICULTURE.

The West Indies.

St. Kitts-Nevis.

The sugar-cane in the fields was small and in certain districts dry and brown as a result of the short rainfall and the high winds. Cotton plants were small but they were heavily laden with flowers and bolls. The following crops, cotton (1930) and sugar-cane (1931) seemed likely to be very short. The sugar crop reaped in 1930 amounted to 18,700 tons of sugar which was a record crop. The Agricultural Superintendent estimated that for 1931 the crop was not likely to exceed 12,000 tons of sugar and that only if good rains came soon. The present season's crop of cotton was expected to amount to not more than 250,000 lb. lint as compared with 327,300 lb. in 1929. Cotton pests had not caused any serious damage, the small attacks of the cotton worm had been controlled by the application of insecticides and the pink bollworm had been found in only a few bolls. No damage was being done by this insect. At the Experimental Station the Sunn Hemp stood up well against the drought in contrast with other green dressing crops. Preparations were being made for an active season in vegetables (principally tomatoes) for the Canadian market. The Government Packing Shed was nearly ready.

Nevis.

The 1929-30 cotton crop in Nevis had been reaped giving a yield of some 274,000 lb. from an estimated area of 2,500 acres. All crops were suffering from the lack of rain and a number of cattle had died from shortage of pasturage and water. Anthrax, which is endemic in the island had again, after a lapse of four years, broken out, and several deaths among cattle and pigs had been caused by Anthrax.

Antigua.

At Antigua the weather was very dry and the crops were suffering as in St. Kitts and Nevis. The sugar crop for 1930 was 18,267 tons of sugar. At Gunthorpe's factory 15,556 tons of sugar were produced at the rate of one ton (2,000 lb.) of sugar from 7.4 tons of cane. The cotton area for the 1930-31 crop was likely to be much larger than in recent years, probably some 700 to 800 acres. The area in sugar-cane is likely to be less as the amount of new planting will be some 2,000 acres less than usual.

Montserrat.

The rainfall in Montserrat had been short, also, and as a result the cotton planting season had been unusually extended in July. There were well-grown cotton fields which had managed to come through well, in full flower and developing bolls, while in others the plants were small and only rarely well established. The danger in such a condition is that the pink bollworm may develop on the early cotton and seriously affect the later planted. The pink bollworm has been remarkably scarce in the West Indies in the past four seasons. In Montserrat, in July, 1930, it is reported that the infestation had not gone over nine per cent. in any count and that it appeared to be decreasing. Progress is being made in the re-establishment of limes. The area now established is probably about 400 to 500 acres. The prospects for a vigorous campaign in the winter vegetable trade are good.

St. Lucia.

At St. Lucia the weather was favourable with a recorded rainfall at the Botanic Gardens of 37.40 inches for the seven months to 31st July. The interest in the fruit trade is maintained and the new Packing House and Cooling Chamber are expected to be ready for the opening of the next season. In common with St. Kitts and Antigua, St. Lucia is feeling the effects of the sugar crisis. Sugar-cane is grown only in certain areas, however, and in other districts the prospects for cacao, coconuts and limes are good, and interest continues to be shown in the development of the fruit and vegetable trade.

St. Vincent.

At St. Vincent the cotton season was over. The change in the planting season, from June to September, had resulted in a greatly improved yield of clean, bright cotton with a very small proportion of stains. Preparations were being made for the planting of a much larger area than in the past season and more attention was being given to the preparation of the land and to the application of manures. The change of season had also resulted in the planting of large areas of early crops of maize and black-eye peas which had done well and were being reaped in July. The pests of cotton had not appeared in sufficient numbers to cause any appreciable losses during the crop. The top working of mango trees for the purpose of converting ordinary seedling trees to the producing of good fruit was being vigorously carried on. A total of 353 trees was reported to have been worked by means of patch budding with from 75 to 80 per cent. of the buds reported to be growing.

Grenada.

At Grenada the Agricultural Department has been active in distributing planting material and considerable interest is shown in extending citrus and other fruits. The maize crop was expected to be a large one and peasants had planted ground provisions to a large extent. The restarting of the Prize Holdings Competitions was giving results in the improved work of peasants on their cacao plots.—(Extracts from *Items of Departmental Interest*, June and July, 1930.)

ENTOMOLOGICAL NOTES.

Compiled by the College Department of Entomology.

The Buffalo Fly.

The problem presented by the buffalo fly (*Lyperosia exigua*) is causing much uneasiness in the northern cattle-raising areas of Australia. The fly no doubt came originally from Java. It is not a pest there, partly because of the existence of natural enemies and partly because the Javanese cattle are much less affected by it than the European breeds of Australia. A few years ago the area of incidence was small, being confined to the immediate neighbourhood of Darwin and the northern coastal region of Western Australia. To-day the fly is found very much farther south, it has entered Queensland on the east, and is spreading rapidly to the west. All the country round Wyndham is heavily infested. Recent reports are that the cattle boats have brought it to Fremantle, but whether it can live so far south remains to be seen. The fly attacks chiefly the flesh at the base of the horn, or any broken portion of the animal's skin. The irritation to which it gives rise prevents the cattle from resting, either by day or by night. The raising of fat cattle for slaughter is rendered almost impossible at certain seasons, and, indeed, it seems possible that this pest may prove to be a main limiting factor in beef production in the northern areas of the Commonwealth. In view of the world position in the beef industry, the situation is disquieting from an Empire point of view.

Dipping methods are useless in dealing with a winged pest of this type; in any case they are out of the question in areas where a cattle muster is possible only once every year, or perhaps two years. A measure of control by parasites or predators seems to be the only practical possibility. Dr. Nieschulz, of the Veterinary Institute at Buitenzorg, has already carried out some investigations for the Council for Scientific and Industrial Research, and has found in Java four parasites which may prove to be of use. Two officers of the Council are now continuing this work, which lapsed when Dr. Nieschulz returned to Utrecht last year. At the same time another entomologist is studying the habits and life-history of the fly in the Northern Territory. Among other questions to which answers must be obtained is that of whether or not the fly is carried by native animals and can breed in their dung. An affirmative answer means that the position becomes very serious, since 'buffer areas' cannot then be made effective in preventing spread. The two problems of the striking of sheep by certain species of blowfly and the irritation in cattle by *Lyperosia* are amongst the most serious and difficult which the animal industry in Australia is facing to-day.—(*Nature*, Vol. 124, No. 3121.)

The Control of Red Weevil (*Rhynchophorus ferrugineus F.*) in Coconut Palms.

Rhynchophorus ferrugineus, F. (red weevil) is the most important pest of coconuts in Ceylon. The stems of young trees four to ten years old are usually attacked; those of mature palms being too hard to permit the penetration and development of the larvae. The crowns of trees of all ages may be attacked when they have been damaged by *Oryctes rhinoceros*, L., or other causes, and wounds or cracks on the stems of young palms also attract the ovipositing weevils. The larvae on hatching, tunnel through the soft tissues of the stem, where the life-cycle is completed. The weevils have been observed to attack other species of palm, including *Caryota urens*.

To prevent infestation, wounding the trees and stripping the leaves should be avoided. Wild pigs and porcupines, which damage the basal parts of young palms, should be kept in check. Heavy nitrogenous manuring promotes rapid and sappy growth, which causes cracks in the bark. Attacked palms should be treated without delay. The infested tissues should be cut out and the cavity painted with tar, filled in with sand and cement mortar and finally cemented over flush with the surface of the stem; rubble or small stones should be substituted for sand when the cavity is large. Since the weevils are attracted to recently killed palms and breed in them for about three months, their use as traps is recommended. *C. urens* forms a very attractive trap, as most of its stem at any age is soft enough to permit the development of the larvae. Young coconut palms that have fallen or the apical parts of recently dead ones of any age to a distance of two or three feet from the crown can also be used. The stems should be split longitudinally into two pieces which should be piled up. Within the first two weeks a number of ovipositing weevils can be captured round the traps; at the end of two months the pieces should be split open and the insects collected and destroyed. In one locality two traps were found to contain 77 and 60 adults and 669 and 737 larvae respectively.—(*The Review of Applied Entomology*, Vol. XVIII, Ser. A, Part 2.)

* * *

Control of Maize Stalk Borer.

The common stalk borers of maize and millet in Kenya are *Busseola fusca*, Fuller, and *Sesamia calamistis*, Hmps., the former being responsible for about 85 per cent. of the damage done. In a successful campaign against the borers in one area, the chief measures were the compulsory notification of their presence, the complete destruction of old maize stalks, set dates for planting, the eradication of self-sown maize, and the appointment of inspectors with full powers to deal with infestations, especially in late-planted maize.—(*The Review of Applied Entomology*, Vol. XVII, Ser. A, Part 12.)

SPORTS.

Hockey Retrospect, 1929-1930.

THE hockey team has had a satisfactory season, and, but for the unfortunate loss through illness of the services of A. K. Briant, it would certainly have improved on its performances.

The constitution of the team, with the exception of the two wing-forward positions, settled itself almost at once, and this helped considerably in producing the good combination which occurred between the half-backs and the forwards during the latter part of the season.

In the Trinidad Hockey Association League, the College team finished third, winning four games and losing three.

Unfortunately, although reaching the final of the Geddes Grant Cup competition, the team could not retain the cup, losing to the Constabulary. The final was an extremely hard fought and fast game, and one of the deciding factors was the better state of training in which the Constabulary side seemed to be.

The following represented the College in the final :—H. L. Manning, S. T. Hoyle, G. Griffith, H. H. Croucher, C. G. Akhurst, D. H. Brown, J. West, C. A. Thorold, A. J. Kerr, N. R. Fuggles, J. B. G. Savory.

Match Results.

Friendly.

1929.			
29th Nov.	*v.* Constabulary (Briant 4).	Won	4-3
1930.			
10th Feb.	*v.* Constabulary (Briant 4, Kerr 1).	Won	5-1
23rd Feb.	*v.* Leaseholds	Lost	0-4
8th Mar.	*v.* Leaseholds (Briant 2, Savory 2).	Won	4-0

Hockey League.

1929.			
6th Dec.	*v.* Queen's Park (Briant 2, Fuggles 1).	Won	3-0
17th Dec.	*v.* Casuals (Kerr 5, Briant 3, Thorold 1).	Won	9-0
1930			
17th Jan.	*v.* Rugby Club (Kerr 2).	Won	2-1
18th Feb.	*v.* Wanderers	Lost	0-2
7th Mar.	*v.* Rovers (Briant 2, Kerr 1).	Won	3-1
18th Mar.	*v.* Constabulary (Savory 2).	Lost	2-5
28th Mar.	*v.* Sporting Club	Lost	0-2

Cup-ties.

25th April	*v.* Rugby Club (Kerr 1).	Drew	1-1
29th April	*v.* Rugby Club (Kerr 3, Fuggles 2).	Won	5-0
8th May	*v.* Leaseholds (Fuggles 2).	Won	2-0

Semi-final.

20th May	*v.* Queen's Park (Fuggles 2).	Won	2-0

Final.

27th May	*v.* Constabulary (Fuggles 2).	Lost	2-5

Summary

Played.	*Won.*	*Lost*	*Drawn.*	*Goals for.*	*Goals against.*
16	10	5	1	44	25

C. G. AKHURST, *Capt.*

* * *

Tennis Retrospect, 1929-1930.

THOUGH not always on the winning side the Club has had a very enjoyable season. Considering the high standard of tennis played in the Island and the peculiarities of tropical courts, the results are quite satisfactory.

Nine matches were played, four being won and five lost. The College was well beaten by Tranquillity in two matches; and against Leaseholds two matches were lost by the narrow margin of three games on each occasion. With the St. Augustine Club, one match was won and the other lost. H.M.S. *Durban* and Caroni were well beaten by the College.

In the College Singles Handicap Cup, Savory, owe 30-3, won from Croucher, owe 30-2, after an excellent struggle, the score in Savory's favour being 6-2, 6-3, 8-10, 6-2.

The following have represented the College on different occasions : A. J. Kerr, H. H. Croucher, J. Wirshing, Professor R. C. Wood, C. G Akhurst, G. M. Roddan, G. G. Gianetti, A. F. Nichols and J. B. G. Savory.

G. M. RODDAN, *Capt.*

* * *

Cricket Season, 1930.

THE Cricket Club may be said to have had a very enjoyable, if not terribly successful season. There was a lack of steady bowling with the result that too much work fell to one man, while the batting showed too great inconsistency ever to give much confidence in it.

Eleven matches were played, five won and six lost. Against the Pointe-à-Pierre XI the College had two good games, each side winning one. The College team was very grateful to members of the Queen's Park Cricket Club who brought teams to the College, and for inviting the College to the Oval, thus providing the team with its one great match. Although their teams were generally much too strong for the College, having certain West Indian and Trinidadian players in them, the value of playing against such men quite outweighed the unevenness of the games. There was one exception when, at the Oval, the College won by six wickets, the two sides scoring 446 runs in the afternoon.

Team :—N. R. Fuggles, C. G. Akhurst, A. J. Kerr, I. C. Young, C. A. Hynam, H. F. Nichols, V. A. Pope, J. B. G. Savory, H. L. Grogan, J. West, A. C. Packer, J. Cave.

IMPERIAL COLLEGE HOCKEY CLUB, 1929-30

Standing : G. Griffith, J. West, S. T. Hoyle, C. A. Thorold, J. B. G. Savory, D. H. Brown, H. L. Manning.

Sitting : H. H. Croucher, A. J. Kerr, C. G. Akhurst (*Capt.*), A. K. Briant, N. R. Fuggles.

IMPERIAL COLLEGE CRICKET CLUB, 1929-30.

Standing : A. C. Packer, I. C. Young, H. L. Grogan, H. F. Nichols, C. A. Hynam, V. A. Pope, J. Cave.

Sitting : J. West, A. J. Kerr, N. R. Fuggles (*Capt.*), C. G. Akhurst, J. B. G. Savory.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

The Hostel Annexe.

Tobacco Seed Selection.

Batting Averages.

	Total runs.	*No. of innings.*	*Times not out.*	*Highest score.*	*Average.*
N. R. Fuggles	383	11	0	104	34.8
C. G. Akhurst	239	10	1	62*	26.6
I. C. Young	316	12	0	74	26.3
C. A. Hynam	206	12	1	56	18.7
J. B. G. Savory	88	10	3	28	12.6
A. C. Packer	38	7	4	21*	12.6
H. L. Grogan	82	10	0	19	8.2
V. A. Pope	77	11	1	19*	7.7
A. J. Kerr	56	9	1	17	7.0
J. West	24	6	1	11	4.8
H. F. Nichols	20	6	0	9	3.3
J. Cave	16	7	2	8*	3.0

Bowling Averages.

	Overs.	*Runs.*	*Wickets.*	*Average.*
H. F. Nichols	31	102	11	9.3
A. J. Kerr	27.4	108	9	12.0
C. G. Akhurst	102	369	26	14.2
I. C. Young	74	231	16	14.4
C. A. Hynam	36.5	136	9	15.1
V. A. Pope	70.5	275	14	19.6

Match Summary.

Played.	*Won.*	*Lost.*
11	5	6

Versus THE STAFF. Won by 125 runs.
Staff: 63 (Young 4 for 10).
College: 188 (Young 34, Fuggles 33, Akhurst 28).

Versus BARCLAY'S BANK. Won by 3 runs.
College: 140 (Hynam 56).
Barclay's Bank: 137 (Akhurst 4 for 28).

Versus POINTE-A-PIERRE (away). Lost by 5 wkts.
College: 147 for 8 declared (Young 74, Akhurst 25.)
Pointe-à-Pierre: 148 for 6 (Pope 3 for 24, Young 3 for 28).

Versus H.M.S. *Wistaria*. Won by 59 runs.
College: 158 (Fuggles 48, Akhurst 28).
H.M.S. *Wistaria*: 99.

Versus G. BURSLEM'S XI. Lost by 7 wickets.
College: 58.
G. Burslems' XI: 133 for 7.

Versus C. H. PACKER'S XI. Lost by 6 wickets.
College: 145 (Young 58).
C. H. Packer's XI: 190.

Versus C. A. WILES' XI Lost by 32 runs.
C. A. Wiles' XI: 113 for 6 declared.
College: 81 (Akhurst 25).

Versus J. L. BAYNE'S XI. Lost by 9 runs.
J. L. Bayne's XI: 165 for 8 declared (Akhurst 4 for 40).
College: 156 (Fuggles 82, Akhurst 32).

Versus POINTE-A-PIERRE. Won by 72 runs.
College: 138 for 8 declared (Savory 28).
Pointe-à-Pierre: 66 (Akhurst 4 for 23).

* Not out.

Versus G. BURSLEM'S XI (at the Oval). Won by 6 wickets.
G. Burslem's XI: 216 for 6 declared.
College: 230 for 4 (Fuggles 104, Akhurst 62*, Hynam 32*).

Versus H.M.S. *Durban*. Lost by 58 runs.
College: 94 (Akhurst 26).
H.M.S. *Durban*: 152 (Kerr 5 for 5.

N. R. FUGGLES, *Capt.*

* Not out.

TOBACCO SEED SELECTION.

THE illustration on page xii shows the process of "bagging" tobacco plants for the purpose of securing pure and uniform seed. The practice is so common that it may be said to have become established as a regular part of the practical business of growing this crop. Suitable plants are chosen and instead of being topped, are allowed to send up a flowering shoot. Before any of the flowers open, after the removal of any flowers that have opened, so that there is no risk of enclosing fertilised flowers, a paper bag is slipped over the whole head and lightly tied. This is only removed when all chances of cross pollination is over. A stake is often fastened alongside the plant to support it. R. C. W.

* * *

THE HOSTEL ANNEXE.

THE photograph on page xii will be familiar to all who have passed through the College. This building was the residence on the property purchased from the late Mr. Carl Boos in 1925 for the erection of the Milner Hostel. It has been adapted as an Annexe with the Hostel and is usually occupied by Senior Students attending "Refresher Courses" and visiting scientists who stay for a few days at the College. A fine specimen of a "Bay" tree stands in front.

* * * G. E.

BANANA FRUIT DISEASES.

Cercospora musae and *C. musarum*.

IN a review of literature on Banana Fruit Diseases published in Vol. VII, No. 5, of this Journal, *C. musae* and *C. musarum*, both of which are banana leaf-spotting fungi, were wrongly regarded as identical. Mr. S. F. Ashby of the Imperial Bureau of Mycology has kindly supplied the following information. *Cercospora musae* Zimm. (*C. musae*, Mass.) appears to be restricted to the East—Ceylon, Java, some Pacific Islands and Australia, while *C. musarum*, Ashby, which is a distinct species, is known only from South America, the West Indies and West Africa. The new name *Helminthosporium torulosum* (Syd.) comb. nov. has now been proposed for the latter species. (*See* Annotated Account of Fungi received at the Imperial Bureau of Mycology, List 2, page 34, 1928.) C. W. W.

REVIEWS.

The Measurement of Hdyrogen Ion Concentration.

By Julius Grant. *Longmans, Green & Co.*, London, 1930. Price 9*s*., pp. 159.

The appearance of this little book is very welcome; it fills a gap in the literature of technological chemistry, and will be of considerable use to those who are concerned with the exact description of the conditions under which chemical reactions take place. In this sense, it will be used by chemists in agriculture, in the fermentation industries, in dyeing, in the manufacture of sugar, in the preparation of leather and of paper, and in the analysis of foods, drugs and water. Sufficient theory is introduced to satisfy the requirements of the general student of industrial chemistry. The technique of the various methods used for measuring hydrogen-ion concentration with the least elaborate apparatus, is clearly described under two main headings, namely, the electrometric method, and the colorimetric method. Simple diagrams, tables of typical data, logarithmic values, and a useful monogram for converting potentiometer readings into pH values, enhance the value of the book, and appeal particularly to the beginner. In addition, lists of references to literature furnish an avenue to further research. A novel feature is a description of modified methods applicable in special cases or in particular industries. To those who find Dr. Mansfield Clark's classical treatise on the same subject rather too detailed for their requirements, Dr. Grant's book may be confidently recommended.

F. H.

ERRATA.

St. Vincent Cotton. By G. E.

In the note entitled "St. Vincent Cotton" on page 246 of Vol. VII, No. 9, Mr. S. H. Evelyn's appointment in the Barbados Agricultural Department should read: "Third Field Assistant." Dr. A. E. S. McIntosh, Ph.D., B.Sc., holds the position of Assistant Geneticist.

Fruit and Vegetables. By G. Evans.

The second and third sentences of the concluding paragraph of "Fruit and Vegetables" on page 240 of Vol. VII, No. 9, should read: There is a slump in prices of all the main agricultural staples produced in *these islands* and planters are only too anxious to *get* an alternative crop that possesses a reasonable hope of *profit*. On the other hand, the *Dominion* Government is anxious to expand the trade with the West Indies and has indicated *its* desire to effect this by the very practical method of *declaring* tariff rates in favour of *these Colonies*. *Note:* The corrected words are in italics.

OBITUARY.

Mr. J. C. Macintyre, M.B.E.

The death of Mr. J. C. Macintyre, M.B.E., Dominica, has removed an outstanding figure in West Indian agriculture. He was formerly a successful lime planter at Hampstead Estate until the Withertip and Blossom Blight Disease completely destroyed the lime industry in that section of Dominica. As Peasants' Adviser he has rendered valuable services to the peasantry of Dominica. He served for many years in the Council of the Government and acted on several occasions as a delegate of the Leeward Islands to the Agricultural Conferences held by the Imperial Department of Agriculture, and was also entrusted with missions to the United States and Canada to develop trade relations with the Leeward Islands. His death will be a severe loss to the Dominica Department of Agriculture which is actively engaged in developments with which he was so largely identified.

H. A. B.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books:—

Agricultural Co-operation in England. A Survey, by The Horace Plunkett Foundation. *Messrs. George Routledge & Sons, Ltd.*, 68-74, Carter Lane, E.C. pp. 272. 7*s*. 6*d*.

Handbook of the Collections Illustrating Agricultural Implements and Machinery. By A. J. Spencer and J. B. Passmore. pp. 96. Plates 16. *H. M. S. Office*, London, 1930. 2*s*.

ACKNOWLEDGMENT.

We have to acknowledge with thanks the following books which have been presented to the Library:

The Mycological Writings of C. G. Lloyd, Vols. 1-6. Cincinnati, U.S.A. Presented by the Lloyd Library, Cincinnati, U.S.A.

The Commissioner of Agriculture recently received a gift of dwarf coconuts from A. P. Skeat, Esq., Londonderry Estate, St. Lucia. There were one dozen each of the Green Dwarf and of the Yellow Dwarf. These nuts were turned over to the Agronomy Department of the College, and it is reported that the nuts have germinated well and are making good growth. This gift is acknowledged with the thanks of the College to Mr. Skeat.

COLLEGE NEWS.

Congratulations are offered to Mr. P. E. Turner, Lecturer in Chemistry and Soil Science, who has been awarded the degree of M.Sc. of the London University.

* * *

Mr. and Mrs. R. E. Hunter and Messrs. D. H. Brown and J. G. Davies, left for a short holiday in Tobago on 9th September and will be away for about ten days.

* * *

Sir Francis and Lady Watts returned from England by s.s. *Ariguani* on 9th August. Sir Francis, who was taken ill a few days after his arrival is now well on the high road to recovery.

* * *

Amongst recent visitors to the College were Mr. Gabriel Descamps, Haitian and Lettonien Consul, Trinidad; Mr. K. T. Rae, Agricultural Superintendent, Grenada, and Mr. R. C. Corbin, West Indies Representative, *Montreal Star*.

* * *

Mr. and Mrs. G. A. Jones, Assistant Professor F. W. Urich and Mr. G. Gianetti returned from England by s.s. *Cavina* on 20th September. Dr. E. A. Seagar and Mr. W. A. Tansley returned from England by s.s. *Magdalena* on 21st September.

* * *

At the meeting of the Agricultural Society of Trinidad and Tobago held on Thursday, 11th September, the Principal addressed the members on "The Possibilities of establishing a Trade in Fruit and Produce between Canada and the British West Indies"

* * *

Dr. L. P. McGuire has gone on a brief visit to Jamaica and Santa Marta with the object of following up on board ship the detailed experimental work on the storage rots of bananas that he has been conducting at the College.

* * *

The Trinidad Government has set up a Committee to inquire into the condition of the cacao industry in Trinidad. The services of Mr. C. Y. Shephard, Professor of Economics at the College, have been specially requested and he will act as adviser on the economic condition of the cacao industry.

* * *

Part IV of the Report of the West Indies Sugar Commission has recently been published as Colonial Report No. 49, (in continuation of Cmd. 3517). This publication contains a Report of the Agricultural Conditions in British Guiana and the West Indies by Mr. G. A. Jones, Assistant Commissioner of Agriculture for the West Indies.

* * *

Mrs. H. R. Briton-Jones returned from England on 6th September by s.s. *Carare*. Dr. J. G. Myers, of the Imperial Institute of Entomology, returned by the same opportunity and will make his headquarters at the College for a further period, with the object of continuing his studies into the biological control of certain of the more important pests of sugar-cane and cacao.

The new Session commences on 4th October, on which date most of the overseas students will arrive. It is expected that there will be about 50 students in residence, 25 being post-graduates and three officers attending for refresher courses. The remainder are taking diploma courses. A full list of the names of those joining the College this year will be given in the next issue.

* * *

The Principal returned to Trinidad by s.s. *Lady Drake* on 4th September after spending a fortnight in Jamaica where he consulted with the Government of Jamaica on matters concerning banana research. He proceeded by s.s. *Lady Rodney* to Montreal and spent rather less than a fortnight in the Dominion. Visits were made to Ottawa for three days where he was the guest of His Excellency the Governor-General and Lady Willingdon, and, where he had the opportunity of meeting the members of the new Government and of inspecting the Dominion Experiment Station. Later on visits were made to MacDonald College and to the Cntario Agricultural College at Guelph. By the courtesy of the Dominion Agricultural Department he was also able to make a brief tour of inspection of the fruit belt of the Niagara Peninsular being accompanied by Dr. Arthur Gibson, the chief Entomologist and Mr. W. A. Ross, the officer in charge of entomological experimental work in that district. Under the auspices of these gentlemen he was enabled to see a good deal of the magnificent extension work of the Agricultural Department. Mr. Evans also spent some time in investigating the possibilities of the fruit and vegetable trade between the West Indies and Canada. After visiting the Annapolis Valley which is famous for its apple orchards, he sailed from Halifax on the 23rd August. On the return journey, two days were spent in Bermuda and he was afforded an opportunity of seeing the work of the local department, and of discussing with Mr. McCallan, the Director of Agriculture, and members of the Agricultural Society, the methods of grading and handling tomatoes and other vegetable crops for export to Canada. All the islands in the Leeward and Windward Colonies were visited on the return journey and at each place the Agricultural Superintendent was met and local matters were discussed with the administrative officials. It is gratifying to note that at most of the islands considerable progress in the organisation of agricultural matters was noticeable, as compared with the previous visit made three years ago. In each Colony the Agricultural Department seems to have assumed a more prominent position in local affairs. Good progress has been made in Dominica in organising a fruit export trade and in the distribution of citrus fruits of superior quality, and it was distressing to learn of the severe damage that had occurred to this island from the hurricane only a few hours after the visit had terminated.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.):

	Foreign.	*Preferential.*
	s. d.	*s. d.*
30th July	5 7½	— —
6th August	5 9	10 3
13th August	5 7½	9 4½
20th August	5 8¾	9 4½
27th August	5 9	9 4½
3rd September	5 7½	9 4½
10th September	5 5¼	9 4½

Messrs. C. Czarnikow, Ltd. report that "Never in the history of the sugar trade have such depressing conditions attended the article for so long a period and prices have now declined far below the most pessimistic forecasts made earlier in the year . . . The tone of markets has been so demoralised that it is impossible to foretell events from day to day. It becomes more and more evident, however, that, discouraging as the outlook is, the statistical position is now no longer the controlling factor in the trend of prices, and it would certainly seem reasonable to assert that the present level cannot be justified by any logical arguments. Nevertheless the fact remains that in the present mood of the trade the factor of ridiculously low prices is not sufficient to bring about a return of confidence." *Messrs. Gillespie Bros. & Co., Ltd.*, state that the Cuban crop closed with an official figure of 4,671,250 tons while Java is estimated to produce 2,850,000 tons, which will entail an enormous carry over into next season. Unless some scheme of restriction can be evolved it is difficult to see how the industry can be resuscitated.

* * *

COTTON.—The following are the official spot prices in pence per pound of the Liverpool Cotton Association:

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
25th July	7·47	12·40	24·50	38·00	—
1st August	7·22	12·20	24·50	38·00	24·50
8th August	7·54	12·35	24·50	38·00	—
15th August	6·89	11.70	24·50	38·00	7·72-27·00
10th Sept. .... (local)	6·40	—	24·50	38·00	—

Prices have declined in spite of the continuance of excessive heat and drought in the belt. Manchester continues inactive and discouraging, and the fear of lower prices tells against business. The Bureau report estimates a crop of 14,362,000 bales which is larger than was generally expected.

* * *

COCOA.—Since last writing the cocoa market has continued in its declining tendency and in New York the market for spot Beans is very dull, manufacturers being hesitant about making purchases under the uncertain conditions ruling.—(*By Courtesy of The Cocoa Planters' Association of Trinidad*).

* * *

COFFEE.—Prices have again been disappointing and lately an almost entire absence of demand has been apparent at Public Auctions. *The Times Trade & Engineering Supplement* of 16th August records averages of 200*s.* for Jamaicas, 120*s.* for Costa Rica Middling, 100*s.* for Kenya Good Middling, and 55*s.* for Brazil Santos, each per cwt. *Messrs. Gillespie Bros. & Co., Ltd.*, state that "a bright spot in the market has been the extreme prices paid for Blue Mountain Jamaica, of which a fair quantity has been offered during the past month; favourable marks realised 226*s.* to 259*s.* for the bold size, 200*s.* to 249*s.* per cwt. for the second size."

* * *

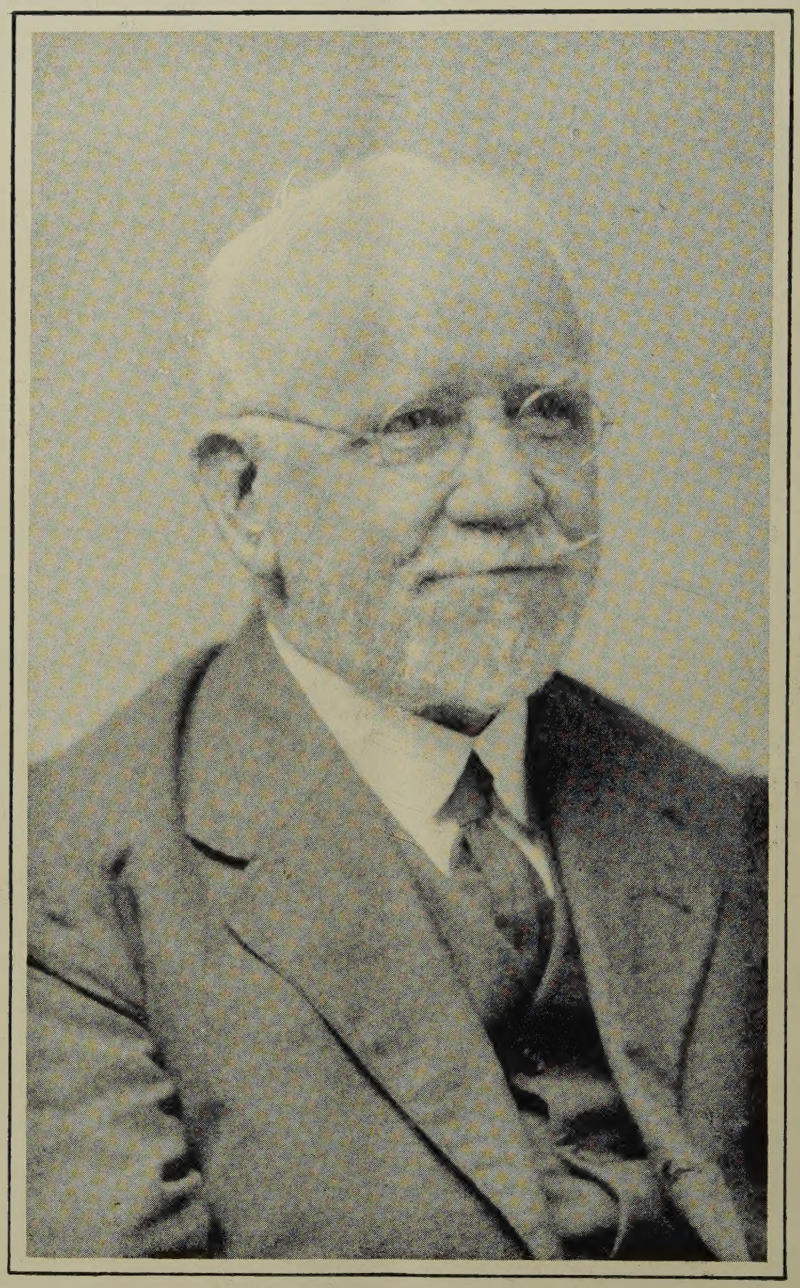
TEA.—Latest weekly averages include Ceylon 17.18*d.*, Indian 12.89d., and Java 9.49*d.*, each per pound wholesale. — (*Times Trade & Engineering Supplement*, 16th August.)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—30th July, 5¼*d.*; 6th August, 5*d.*; 13th August, 4$\frac{11}{16}$*d.*; 20th August, 4$\frac{13}{16}$*d.*; 27th August, 4¾*d.*; 3rd September, 4⅝*d.*; 10th September, 3$\frac{15}{16}$*d.* A suggestion of hardening prices in the latter part of August was rapidly dispelled and prices have fallen to new record levels. Consumption figures are very disappointing. *Messrs. Symington & Sinclair* report that the total U.S.A. consumption for the first seven months of 1930 amounted to 249,955 tons compared with 310,834 tons for the same period of 1929, a decrease of almost 61,000 tons. *Messrs. Lewis & Peat* state that low prices have had no effect in reducing outputs; on the contrary July returns show a considerable expansion over July last year. The outlook is dismal. Some 55 per cent. of the world's estimated area under Plantation Rubber is under British control and 40 per cent. under Dutch control. No definite scheme of restriction has yet met with agreement.

* * *

BANANAS.—Jamaicas are again lower and quoted to day to wholesalers at £21 delivered (London) or £20 10*s.* delivered nearest railway station; the price to retailers is about 10½*d.* per dozen. Brazilians are in good demand and unchanged at £22 per ton delivered nearest railway station. — (*West India Committee Circular*, 21st August.)



The late Sir FRANCIS WATTS, K.C.M.G., D.Sc.